SCIENTIFIC INQUIRY AS SOCIAL AND LINGUISTIC PRACTICE:

LANGUAGE SOCIALIZATION PATHWAYS

IN A NINTH-GRADE PHYSICS CLASS

by

Sarah Katherine Braden

A dissertation submitted to the faculty of
The University of Utah
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Department of Linguistics

The University of Utah

December 2016

The University of Utah Graduate School

STATEMENT OF DISSERTATION APPROVAL

The dissertation of **Sarah Katherine Braden**

has been approved by the following supervisory committee members:

MaryAnn Christison	, Chair	**10/17/2016** Date Approved
Marianna Di Paolo	, Member	**10/17/2016** Date Approved
Adrian Palmer	, Member	**10/17/2016** Date Approved
Steven Sternfeld	, Member	**10/19/2016** Date Approved
Sonya Martin	, Member	**10/17/2016** Date Approved

and by **Patricia Hanna** , Chair/Dean of

the Department/College/School of **Linguistics**

and by David B. Kieda, Dean of The Graduate School.

ABSTRACT

English Language Learners (ELLs) in K-12 schools in the United States have lower standardized test scores and lower high school graduation rates than their native-English speaking peers. Similar performance gaps exist for Latino/a students when compared to White non-Latino/a students, even if they are not identified as English learners and were schooled in the United States. Language minority students are also underrepresented in STEM (science, technology, engineering, and mathematics) fields. Equity in access to STEM degrees and professions is a social justice issue with economic implications. STEM careers provide economic security for individuals and growth in STEM industries is important for the U.S. economy. As the demographics in the United States change to include more workers from language minority backgrounds, it has become even more imperative to ensure equitable access to STEM careers.

Traditional approaches to studying equity for K-12 language minority students in the sciences focus on narrowly defined pedagogical methods aimed at improving the performance of language learners on science assessments. However, language socialization research using ethnographic methods suggests that students' classroom-based social positioning shapes their learning and their affiliation or disaffiliation with particular disciplines. Thus, this dissertation explores science expertise as a discursively constructed stance not as a set of acquired facts.

In this dissertation research, I use ethnography and classroom discourse analysis to study peer group interactions and explore how language minority students either achieve or do not achieve science expert status in their physics lab groups. In order to trace the language socialization pathways of three Spanish-English bilingual Latina students, it was also necessary to document community-level norms related to academic success.

The findings in this dissertation center on these two phenomena: classroom-level identities related to academic success during lab work and the experiences of language minority students as they navigated social interactions during lab tasks. Classroom-level findings suggest that students oriented to three local identities related to academic success: (1) the science expert, (2) the good student, and (3) the good assistant. Looking across the socialization pathways of the Latina students in the class revealed that their identities as Latinas and Spanish-speakers intersected with their ability to articulate science expert status in complicated ways. I conclude this dissertation with implications for research on Latino/as in STEM, classroom discourse studies, language socialization research, and science teacher education.

TABLE OF CONTENTS

Appendices

LIST OF FIGURES

Figures

LIST OF TABLES

Tables

ACKNOWLEDGEMENTS

I owe so much to so many that these acknowledgements are undoubtedly incomplete. First, I would like to thank the teachers and students with whom I worked in high schools in Philadelphia and Utah. My years as a classroom teacher informed the research questions I developed for this dissertation and they continue to inform my practice as a teacher educator and researcher. I also thank the teacher and students in the ninth-grade physics class in which this work was conducted. I was continually impressed by and grateful for their insights about their experiences learning and teaching physics, and their lives both inside and outside of the school community.

This dissertation would not exist without the unwavering support of my advisor, Dr. MaryAnn Christison. Dr. Christison is a skilled teacher educator and I have learned much from observing and emulating her practice. As a scholar in the field of teacher education Dr. Christison's wide-ranging knowledge base and her passion for supporting teachers in meeting the needs of the language learners in their classrooms provided me with a model for how to conduct research that has both theoretical and practical implications. I am forever indebted to Dr. Christison for the time and effort that she invested in helping me to develop as a scholar and teacher educator.

I am also indebted to my committee for their support during the many phases of this degree. Dr. Adrian Palmer's humor and attention to detail in his teaching practice provided me with a model for how to engage students with difficult subject matter. Dr.

Steven Sternfeld drew on his years of experience in language education to provide helpful suggestions for how to improve the study design for this dissertation. Through her lens as a sociolinguist and an exemplary scholar, Dr. Marianna Di Paolo provided critical insights that informed the research design and writing phases of this dissertation. Dr. Sonya Martin brought her wisdom and experience as a science education scholar to providing suggestions for how to move forward with a research agenda that connects the work presented in this dissertation with the concerns and backgrounds of science teacher educators. I am grateful to have been guided in completing this dissertation by such a caring and gifted group of scholars.

Thank you also to The International Research Foundation for English Language Education (TIRF) for supporting this research through a Doctoral Dissertation Grant. The funds from this award provided critical resources that enabled me to conduct many months of ethnographic fieldwork.

Thank you also to Dr. Ed Rubin who served as the Chair of the Department of Linguistics for 6 of the years that I was enrolled as a student, and to Dr. Patricia Hanna who serves as the current Chair. To the Department of Linguistics faculty who engaged me in challenging coursework and pushed me to develop my knowledge base as a linguist I am grateful for the breadth and depth of knowledge that you provided me.

Lastly, thank you to my parents, my husband Christopher, and my sister Amy, for supporting me in this endeavor and for believing in me when I did not believe in myself. I truly could not have completed this dissertation without your love and support.

CHAPTER 1

INTRODUCTION

By measures such as high school graduation rates, standardized test scores, and over-identification for special education classes, racial, linguistic, and economic minority students in the United States do not perform as well as their native-English speaking economically advantaged White peers[1] (Abedi, 2006; MacSwan & Rolstad, 2006; Sullivan, 2011; U.S. Census Bureau, 2011). Understanding how these achievement gaps are constructed and perpetuated in individual classrooms provides one entry point to understanding and addressing equity in public education. Carlone, Haun-Frank and Webb (2011) argue that the term *achievement gap* does not adequately frame the issue of equity in science education because it implies that lower performing students have deficits that must be addressed primarily through instructional interventions. As in, framing equity issues around students' skill development erases the social and institutional structures that impact the learning of minority students in schools.

Carlone et al. (2011) conducted a comparative ethnography in fourth-grade science classes and found that despite showing positive attitudes towards the science class and high levels of skill, the African American and Latina students in one classroom

[1] I acknowledge that these categories are not always mutually exclusive. For example, a Latino/a may

did not identify themselves as smart science people. The authors emphasize that the classroom culture that caused minority students to disaffiliate with science emerged despite the teacher's high level of skill in reform-based science teaching[2] and her goal of creating an equitable classroom. Thus, Carlone et al. (2011) reframe equity in science education as equity of access to skills, positive affect, and appropriation of smart science student identities. Although Carlone et al. (2011) address how teacher-driven communicative practices of each classroom contribute to students' desire to affiliate or disaffiliate with science, they do not evaluate how students show or develop these stances during classroom interaction. Understanding the processes of affiliation and disaffiliation would provide teachers and teacher educators with additional information about the ways that individual students become marginalized from the classroom community in day-to-day interaction. This dissertation offers a microlevel analysis of students' identity stances reflected by their language use during classroom tasks to reveal how and when students incorporate or reject identities related to science expertise into their linguistic and cultural repertoires.

Brown (2004) provided an excerpt of science classroom interaction that showed how a 10th-grade student's desire to show solidarity with the other African American students in the class led him to explain a scientific concept using language that lacked the specificity needed to demonstrate a scientific understanding of a particular phenomenon (in this case, virus replication). I argue here that by studying the identity pathways of individual students by tracing their uses of language to affiliate or disaffiliate with various identities, we may also see how student identity work constrains or supports

[2] In 1996 the National Academy of Science published a new set of standards for science education that ushered in a new era in reform-based science teaching. The term "reform-based science education" refers to the tenets set forth in this document.

academic language learning. Thus, including access to appropriating a smart science student identity into our notion of equity in science education brings with it the corresponding need to address academic language use in practice and to understand the various success-related identities in individual classroom communities.

As state-run institutions, U.S. public schools simultaneously reflect and perpetuate the social and economic inequalities present in society. The underrepresentation of minority groups such as African Americans and Latino/as in science, technology, engineering, and mathematics (STEM) fields exemplifies one of these societal inequalities. Students identified in national surveys, as English Language Learners (ELLs), African American, and Latino/a are more likely to live in poverty than are other demographic majority groups (U.S. Census Bureau, 2011). Although statistics on the percentages of ELLs who enter U.S. public schools and who subsequently enter STEM fields are not available, the fact that U.S. educated ELLs are less likely to graduate from high school than native English speakers (U.S. Census Bureau, 2011) provides some evidence that domestic language learners are underrepresented in STEM careers that require education beyond high school. This may be particularly the case for English learners who find themselves dually minoritized in the United States as members of linguistic, as well as racial and ethnic minority, groups. This multigroup positioning makes statistical studies based on traditional demographic categories complicated to interpret (see Bailey, 2001 for a description how a group of second generation Dominican-American students of African descent resist their identification by others as African American). With these caveats aside, the underrepresentation of minority groups in STEM fields is concerning due to the opportunities for upward economic mobility that

STEM careers provide. People working in STEM professions have higher lifetime earnings than people who work in other fields, and people who earn 4-year degrees in STEM fields have higher lifetime earnings than people who earn 4-year degrees in other fields regardless of whether or not they work in STEM professions (U.S. Department of Commerce, 2011a, 2011b).

Lewis, Menzies, Nájera and Page (2009) reviewed trends in minority students' participation in undergraduate and graduate STEM programs through the lens of the biological sciences. The authors focused on the biological sciences because this domain of STEM education had the largest percentage of domestic minority students enrolled when compared to other STEM disciplines. Lewis et al. (2009) found that despite overall increases in the numbers of Latino/as participating in STEM degrees at the undergraduate and graduate levels over time, when controlled for increases in population size, there was no increase in the participation of Latino/as enrolling in STEM degree programs or attaining STEM degrees. The researchers also developed a ratio indicator to show the relative quantities of underrepresentation of various minority groups in the sciences. In 2004 (the most recent year of data analyzed in the study) Latino/as had an undergraduate participation ratio of 0.78, meaning that Latino/as participated in biology undergraduate programs at 78% of their representation in society (11.3% enrollment in biology programs/13% of the general population). In that same year the graduation ratio for undergraduates was 0.52. Graduate enrollment was 0.64, and biology doctorates awarded were 0.33. These numbers demonstrate the underrepresentation of Latino/as in the biological sciences at various stages of academic progress in the biological sciences.

Though Lewis et al. (2009) did not analyze participation rates in other STEM fields they indicate that underrepresentation in these fields likely demonstrates a more dire situation given that the biological sciences had the highest rates of minority student participation. Some researchers refer to the progressively more severe underrepresentation of Latino/as in STEM degrees moving from undergraduate to masters and then doctorate programs using a leaky pipeline metaphor. Under this metaphor, students "leak" out of the pipeline when they encounter barriers to their academic progress that prevent them from completing degrees or earning additional degrees at rates that match other racial, ethnic, and linguistic groups. However, Rochin and Mello (2007) argue that the pipeline metaphor creates a negative stereotype for Latino/as in STEM and they propose a pyramid metaphor that acknowledges barriers to students' access to progressively higher levels of education.

There are multiple causes for the discrepancies in representation in the STEM fields described above. Although ensuring that students have the adequate skills to enter STEM careers is important, Carlone et al. (2011) showed that having skills and a positive attitude about science does not ensure that students will affiliate with science and view themselves as potential scientists. Brown's (2004) work also showed that maintaining certain identity positions conflicted with students' use of academic language and construction of scientifically accurate descriptions of phenomena. We are left with the following questions: How do teachers shape the practice of doing science in science classes to improve minority students' desire to affiliate with science professions? How should teachers structure tasks to provide minority students, who may not have access to scientist parents and financial wealth, with opportunities that build expertise in STEM?

In this dissertation I argue that in order to address these questions, researchers must understand how students are socialized into or out of science identities. Classroom-based language socialization (LS) research provides one approach to understanding differential academic success by documenting the local communicative practices that establish and reinforce the subjugation of particular students (e.g., Heath, 1983; Philips, 1983). The underrepresentation of minority students, and Latino/as in particular, in the sciences provides motivation for language socialization research that seeks to understand what language practices students must master in order to become experts in doing science. Furthermore, an LS framework allows researchers to explore the ways that the teacher and students build classroom culture through interaction. This dissertation research provides an account of science classroom discourse socialization and identity development, which teachers and teacher educators might use to examine how expertise develops in other classroom communities and how English learners are impacted by community norms for articulating expertise. With this view comes also new perspectives on how teachers might structure group work to either facilitate all students' access to the type of expertise being demonstrated in their classroom, or to ways to change classroom values around what counts as relevant expertise in their classrooms.

In addition to addressing the practical problem of equity in science education, language socialization research also contributes to theory building in second language acquisition (SLA) (Duff & Talmy, 2011). One of the fundamental problems that SLA researchers must explain is why, under similar instructional settings and with similar exposure levels, English learners exhibit a wide range of language learning abilities and outcomes. SLA researchers approach the study of language acquisition from many angles ranging from experimental studies aimed at elucidating cognitive aspects of language learning (e.g., Hayes-Harb, Nicol & Barker, 2010), to quasi-experimental classroom-based studies aimed at understanding how learners perform on language learning tasks as a result of particular instructional treatments (e.g., Doughty & Williams, 1998; Norris & Otega, 2000). Of particular relevance here is foundational SLA research on identity (e.g., Norton Pierce 1995) and language socialization (e.g., Duff, 1995).

Norton Pierce (1995) conducted a qualitative study that showed that the social identities available to adult language learners outside of the classroom influenced their language learning opportunities and trajectories. Duff (1995) also showed how macro-level political changes impacted classroom instruction and led to shifts in the way that a second language (in this case English as a foreign language in Hungary) was taught and learned. Duff (2002) also documented how non-native English speakers in a mainstream classroom containing L1 and L2 English speakers were positioned to take up non-participatory roles in their history class as a result of student turn-taking patterns despite exhibiting high levels of skill and knowledge in their written work.

The various approaches to studying L2 acquisition and classroom–based learning described in the previous paragraphs reveal the breadth of approaches to SLA in applied linguistics. In this dissertation I argue for an approach to SLA research that acknowledges that cognition occurs embedded in social contexts and that the process of learning a second language is constrained by both biology and context. This particular study explores context by documenting the ways in which three Spanish-English bilingual learners position themselves and are positioned by others to take up or reject local identities related to academic success during science inquiry tasks. I relate this social positioning to students' language and content learning opportunities. I explore cultural and linguistic practices by pairing traditional ethnographic fieldwork with a detailed analysis of classroom discourse.

In documenting how the social context in one science classroom affects students' language and content learning, this research fills gaps in the literature in science education and applied linguistics. Though there are studies of science classroom discourse practices (Lemke, 1990) and the development of discursive identity in science classes (Brown, 2004; Brown, Reveles, & Kelly, 2005), no studies currently address how second language or bilingual learners simultaneously navigate the social and disciplinary language practices that they must learn in order become proficient student-scientists. In addition, this study focuses on inquiry instruction, which is aimed at exposing students to the process of doing science. This study adds to the body of knowledge on inquiry instruction by documenting the linguistic and social demands on students during inquiry tasks and by exploring how students' negotiations of these demands affect learning and their affiliation with science identities.

From an applied linguistics perspective, there are no studies that explore academic discourse socialization with ELLs in science classes using the approach detailed here. Much of the academic discourse socialization research focuses on older learners or other types of academic discourse (Duff, 2010). In addition, LS research that combines ethnography and classroom discourse analysis often focuses on settings with whole class discussions where the teacher is the institutionally appointed and interactionally salient expert. In inquiry tasks, students work in small groups and they must negotiate expertise. This case study then contributes to the body of LS work that explores how peers socialize one another to use language in particular ways. This case study contributes to researchers' understandings of the linguistic expectations placed on students working in peer groups in class, and it provides an example of how one set of bilingual learners navigate those expectations in moment-to-moment interaction. In doing so, this work also contributes to research on language and identity that spans the disciplines of sociolinguistics and linguistic anthropology.

In summary, in order to improve the representation of English learners and Latinas/os in STEM fields, researchers need to understand how differential academic success is co-constructed by students and teachers in individual classrooms. Research on the needs of language learners in public schools, and in science classes in particular, spans the disciplines of applied linguistics, sociolinguistics, linguistic anthropology, and science education. This dissertation research draws from work in each of these fields and applies an LS framework and an identity-based approach to analyzing classroom discourse and to understanding how students from various language backgrounds develop science classroom identities while conducting scientific inquiry projects. The identities that students co-construct with other students and teachers are inextricably linked to their content (Wortham, 2005, 2006) and language (Gee, 1996; Norton, 1995; Norton & McKinney, 2011) learning.

In this research I am guided by and ask the following questions:

1. (a) What local identity models are associated with success during inquiry instruction in one ninth-grade physics class? (b) How do students discursively construct these identities?
2. (a) What pathways of socialization do three bilingual Latina students undergo

while participating in science inquiry labs? (b) How do these pathways relate to students’ language and science content learning?

CHAPTER 2

LITERATURE REVIEW

This chapter begins with a description of the theories of language, discourse, identity, power, and learning that frame this ethnographic case study (Section 2.1). Section 2.2 reviews language socialization research in various contexts. Section 2.3 describes characteristics of classroom discourse and science discourse. Section 2.4 reviews literature on inquiry instruction and language learning in science education.

2.1 Language, Discourse, Identity, Learning, and Power

In order to begin a discussion of language socialization and later to refine this discussion to focus on academic discourse socialization during science inquiry tasks, it is essential to first explore and define the terms *language*, *discourse, identity* and *learning* as they are used in this dissertation.

2.1.1 Orientations to Language

For Chomsky (1965) “linguistic theory is concerned primarily with an ideal speaker-listener, in a completely homogenous speech community, who knows its language perfectly” (Hymes, 1972, p. 269) and in a context free manner. Programs of linguistic theory in the Chomskyian tradition are concerned with theories of mind. These theories focus primarily on structural systems (e.g., minimalist syntax) (Hornstein, Nunes, & Grohmann, 2005) that unify languages rather than on patterns of use that reflect cultural and social phenomena. In response to Chomsky's decontextualized theory of language, Hymes (1972) introduced the notion of *communicative competence,* which draws attention to the flexible deployment of grammatical resources in social communication. Hymes (1972) cites sociolinguistic research by Gumperz (1964), Hymes (1968), and Labov (1966) to support his claim that, "what to grammar is imperfect or unaccounted for, may be the artful accomplishment of a social act" (p. 272). Instead of evaluating utterances based only on grammaticality judgments, Hymes (1972) proposes that language be evaluated based on four criteria that account for the sociocultural variables that influence language use:

1. Whether (and to what degree) something is formally *possible*;
2. Whether (and to what degree) something is *feasible* in virtue of the means of implementation available;
3. Whether (and to what degree) something is *appropriate* (adequate, happy, successful) in relation to a context in which it is used and evaluated;
4. Whether (and to what degree) something is in fact done, actually *performed*, and what it's doing entails. (p. 281)

Communicative competence is defined as a person's ability to negotiate these four aspects of communication using language. Inherent in this notion is the underlying assumption that speakers exhibit variation based on their different life experiences. In order to make sense of language as it is employed in social acts and conceptual thought, Hymes (1972) advocates for building theory through investigations of language in use and according to the four criteria outlined above. He claims that "what must be known [about language] is the attitude toward the differences, the functional role assigned to them, [and] the use made of them. Only on the basis of such functionally motivated descriptions can comparable cases be established and valid theory developed" (p. 289). Hymes (1972) advocates for a descriptive focus on verbal repertoires (the varieties of language that individuals employ to enact different social functions), linguistic routines (the sequences of verbal and nonverbal communication that characterize certain social functions), and domains of language behavior (sociocultural entities that are defined by topic, locale, and role relations) (Fishman, 1972). Based on this description, it becomes clear that Hymes's (1972) approach to understanding linguistic competence grounds knowledge of language in social contexts and that under this approach, there is little value in studying language separate from its context of use.

I advocate for a pluralistic and interdisciplinary approach to studying language. I believe that understandings of language are advanced by the exchange of empirical data and theoretical notions across four domains of language study: use, structure, acquisition, and change.[3] One might imagine these as four points on a symmetrical pyramid where an understanding of one domain must be grounded in its connections to the other three domains. For this dissertation research, I use theoretical constructs related to language use in social contexts to explore factors that may influence students' language acquisition trajectories, thereby investigating one link between two domains of study.

Although this dissertation draws on the Hymsian tradition and takes communicative competence in a science classroom community as the primary object of study, this construct alone is not powerful enough to capture the interactional processes that shape students' development of communicative competence. In order to explore what communicative competence looks like and how it is attained in a social context, researchers must analyze discourse.

[3] By language change I am referring to insights from diachronic or historical linguistics.

2.1.2 Definitions of Discourse

Definitions of discourse vary across the subdisciplines of linguistics and applied linguistics. Gee (2011) provides a useful distinction between "discourse" (language) and "Discourse" (ways of being):

> Such socially accepted associations among ways of using language, of thinking, valuing, acting, and interacting, in the "right" places and at the "right" times with the "right" objects (associations that can be used to identify oneself as a member of a socially meaningful group or "social network"), I will refer to as "Discourses," with a capitol "D". I will reserve the word "discourse," with a little "d," to mean language in use or stretches of language (like conversations or stories). "Big D" Discourses are always language *plus* other "stuff."" (Gee, 2011, p. 34)

Under Gee's conception, language represents only one of the meaning-making resources that contribute to a Discourse, and Discourses "are about being different kinds of people" (p. 34). Discourse analysis, according to Gee (2011) involves examining the ways in which people's identities are validated, shaped, constrained, or challenged by interaction with others. Gee (2011) highlights the importance of recognition in constructing an identity:

> If you put language, action, interaction, values, beliefs, symbols, objects, tools, and places together in such a way that others *recognize* you as a particular *who* (identity) engaged in a particular type of *what* (activity), here and now, then you have pulled off a Discourse (and thereby continued it through history, if only for a while longer). (p. 35)

The distinction Gee (2011) draws between language use, "discourses," and ways of being, "Discourses" is useful for this language socialization study because it draws attention to the idea that attaining communicative competence requires more than simply knowledge of appropriate linguistic practices. Big "D" Discourse analysis then requires that analysts invoke additional tools to understand how language use integrates with other communicative acts (e.g., clothing, gesture, tool use, etc.). Thus, while my analyses center on language, I examine co-occurring nonlinguistic signs as they provide insight into interpretations of the "discourse."

Agha (2007) provides a theory for how ways of speaking become codified into recognizable registers that come to index social types. Part of Agha's (2007) approach includes describing how microlevel interactions add up to macrolevel social categories. For example, Agha (2007) describes how Received Pronunciation in Great Britain came into existence and how it became ideologically linked to other signs of class and education. Agha (2007) identifies *reflexive activity*, the use of communicative signs to typify other signs, as central to enregisterment—the process whereby distinct forms of speech come to be socially recognized (i.e., enregistered) as indexes of speaker attributes. Although this dissertation does not explore enregisterment on a societal scale (for example by trying to describe characteristics of "scientist speech"), much of the theoretical machinery Agha (2007) developed can fruitfully be applied to a smaller context. Of particular importance here, is the notion of *participant-linked speech chains* or *speech chains*. Agha (2007) describes speech chains in the following way:

> The chain consists of a historical series of speech events connected together by the permutation of individuals across speech-act roles in the following way: the receiver of the message in the $(n)^{th}$ speech event is the sender of the message in the $(n+1)^{th}$ speech event. (p. 67)

The speech chain construct helps to demonstrate the ways that language in use (discourse) works to construct social relations and culture over time as participants continually circulate particular ways of speaking. In order to understand the discursively constructed identities in one ninth-grade science classroom, it is essential to investigate how utterances are intertextually linked to each other over time in the community through speech chains. These linked communicative acts construct local identities.

2.1.3 Language, Identity, and Learning

Bucholtz and Hall (2004) begin their discussion of the relationship between language and identity by claiming that, “among the many symbolic resources available for the cultural production of identity, language is the most flexible and pervasive” (p. 369). Bucholtz and Hall (2004) maintain that the term identity refers essentially to sameness. Thus, when a person performs a certain identity, he or she affiliates with a particular group and consequently, disaffiliates with some other group or groups. From a school-based language socialization perspective, changes in identity are inherent in becoming a successful or unsuccessful student. In moving from novice to expert, a person takes up a new identity position as a consequence of acquiring the expert knowledge base.

However, “sameness and difference are not objective states but are phenomenological processes that emerge from social interaction” (Bucholtz & Hall, 2004, p. 369). Thus, an expert is an expert in so far as he or she performs or authors the identity of expert in social interactions. Many language and identity scholars provide empirical evidence to support the notion of identities as the products of performance as opposed to inherent properties of individuals based on race, gender, class and other observable characteristics (Bailey 2001; Barrett, 1999; Bucholtz, 2011; Chun, 2001, 2007; Eckert, 2000, 2012; Wortham 2005, 2006, 2008). Under this conception of identity, as created and perpetuated via performances, Bucholtz and Hall (2004) claim that “externally imposed identity categories generally have at least as much to do with the observer’s own identity position and power stakes as with any sort of objectively describable social reality” (p. 370). For example, the term Limited English Proficient

(LEP) has been used by the United States federal government to label all second language (L2) English users in public schools and all levels of proficiency, even users who are highly proficient, and the criteria by which this label is applied to L2 English users arguably tell us more about the values of the United States government than it does about any particular student who has been labeled with this term.

Bailey (2001) documented how second generation Dominican-Americans developed a “reactive ethnicity” in response to being labeled by others as African American. The participants in Bailey’s (2001) study distinguished themselves from their African American peers and instead identified themselves as Spanish or Dominican by the strategic use of Spanish. Citing Monica Heller’s work (1999; see also Heller, 2001) with high school students in Canada, Bucholtz and Hall (2004) point out that, “social grouping is a process not merely of discovering or acknowledging a similarity that precedes and establishes identity, more fundamentally, of inventing similarity by downplaying difference” (p. 371). This again contests the validity of grouping people into identity categories based on physical attributes. Although I explore the identity work of three bilingual Latina students in one science classroom, I did not assume that any particular dimension of students’ racial or linguistic backgrounds would factor into their articulation of classroom level identities. In their analyses of identity formation Lemke (2000) and Wortham (2006) describe the ways that macrolevel categories such as race, gender, and language background, inform participants’ interaction with each other and are used as resources for constructing emergent locally salient identities. The local identities are distinct from, though informed by, these other models (Lemke, 2000; Wortham, 2006).

Wortham (2006) refers to classroom level identities as *local identity models* or *local metapragmatic models*. An identity model is “either an explicit account of what some people are like or a tacit account that analysts can infer based on people’s systematic behavior towards others” (Wortham, 2006, p. 6). These models may be sociohistorical (e.g., disruptive student, loud Black female) or local (e.g., a beast). The local beast model emerged in a ninth-grade classroom in which Wortham (2006) conducted a year-long classroom ethnography. Two students in this classroom were consistently positioned as beasts or outcasts over the course of the school year as a result of both teacher and student actions. In this example a teacher initiated the model of the beast during a whole class discussion in which she used a participant example (Wortham, 1994) to relate the concepts in a text by Aristotle to students’ lives. In attempting to help students make sense of the text the teacher selected two students to act in the role of beasts. Wortham (2005, 2006) traces the *trajectories of socialization* followed by each of these two students from this focal event across other contingent events as they continued to be positioned as outcasts over the course of the school year. Wortham (2005, 2006) argues that the local models that emerge in interaction are dependent on intertextual references (contingent events) and references to multiple “timescales” (Lemke, 2000).

Using a different methodological approach, Carlone et al. (2011) described differences in the local identity models of the smart science student in two different fourth-grade classrooms. Though the local model in one classroom showed a significant influence from a socio-historical model of the good student (e.g., displays knowledge for the teacher by answering questions in initiation-response-evaluation sequences), the model developed in the other classroom studied by Carlone et al. (2011) was distinctly local (e.g., asks good questions). This example points to the importance of viewing models as in flux, and informed by multiple timescales, both historical and immediate, as opposed to static entities. Wortham (2006) employs Lemke's (2000) notion of *timescales* to address the ways in which single moments are interpreted by individuals according to multiple points of reference simultaneously. For example, Carlone et al. (2011) showed how one female student simultaneously performed identities related to strong female and smart science student in one interactional sequence while personifying a mother giraffe during a science class presentation. In his discussion of how "moments add up to lives" (p. 273) Lemke (2000) conveys the importance of recognizing how different timescales of human experience shape and are shaped by events at both smaller and larger timescales.

Rather than limiting their analyses of classroom interaction to one of these levels at a time, Lemke (2000) and Wortham (2006) advocate for integrated analyses that acknowledge the simultaneous performance of identities across multiple timescales. As is evidenced in Wortham (2006) and Carlone et al. (2011), local identity models are "constrained by longer timescale processes but cannot be fully predicted from those longer timescale processes" (Wortham, 2006, p. 9). Thus, the only way to understand how students in a particular classroom become positioned into different classroom identities is to study classroom interaction. Wortham (2006) delineates the *local timescale* as a "spatiotemporal niche bounded spatially by…[the teacher's classroom]…and temporally by the academic year in question" (p. 44).

Up to this point I have claimed that identities exist on multiple social levels and are forged in social interaction across multiple timescales. But, what is an identity?

Bucholtz and Hall (2004) provide a working definition that I use in this research project:

> *Identity*: An outcome of cultural semiotics that is accomplished through the production of contextually relevant sociopolitical relations of similarity and difference, authenticity and inauthenticity, and legitimacy and illegitimacy. (Bucholtz & Hall, 2004, p. 382)

This definition highlights three paired *tactics of intersubjectivity* that Bucholtz and Hall (2004) use to explain *why* different social identities emerge in various contexts. *Adequation*, "the pursuit of socially recognized sameness" (Bucholtz & Hall, 2004, p. 383) and *distinction* refer to coalition building often for political purposes. *Authentication* (the process whereby a speaker asserts the authenticity of his/her performed identity) and *denaturalization* (separation from claims of authenticity) can operate on large scales (e.g., nationalist rhetoric) or on small scales that are more evasive (e.g., gender identities in Barrett's 1999 description of African American drag queens). *Authorization* (the process by which dialects or registers attain power and status, for example, standardization) and *illegitimation* (the loss of power) are often facilitated by institutions. The three binary pairs listed in this definition of identity carry with them a theme of power relationships. Any type of labeling that distinguishes groups does so at the cost of applying a power relationship to the members of these groups (Foucault, 1980).

Wortham (2006) bases his description of the connection between social identification and academic learning on Foucault's construct of "power/knowledge." Foucault (1980) shows how the concept of knowledge as an instrument of power masks the power relationships that are inherent in any learning because some learning leads to a decrease in power. Foucault (1980) traces the history of the social practice of institutional labeling in prisons and schools and shows that in any act of learning one inherently gains or loses a position of power. Bourdieu (1999), with his metaphors related to social capital, echoes this notion of power brokering as inherent in learning. Wortham's (2006) ethnographic work provides an empirical case that documents the ways academic learning and social identification are intertwined and have consequences for power relations in the classroom.

Brown (2004) provides a piece of data (Table 4 on p. 827) which outlines a conversation that took place in a whole class setting among two students (Emmanuel and O'Tanya) and the teacher in a high school biology class. These data exemplify the need to challenge the assumption that academic school-based learning results in a gain of social capital for students. In the exchange Emmanuel appears to decrease his use of academic language in order to socially identify with a particular peer, O'Tanya, and perhaps a peer group of African American students in this class. If Emmanuel had persisted in using academic language, which O'Tanya admonished him for using, he could have experienced a loss in social status and power in a group that was socially meaningful to him.

There are multiple possible interpretations of the talk in the vignette supplied by Brown (2004). Brown (2004) used the data as an exemplar of how one student discursively constructed a "maintenance" stance with regard to his use of science discourse. Brown (2004) identified four different identity stances with respect to developing science literacy and science identities: opposition status, maintenance status, incorporation status, and proficiency status. Interestingly, some of the L2 English speakers in Brown's (2004) study were better able to develop incorporation or proficiency statuses than L1 English speakers. The speech sample provided by Brown (2004) shows how power is embedded in learning and how social positioning or identity work can constrain students' use of academic language as it is defined and used in its local classroom context.

Brown's (2004) analysis of talk in one classroom does not include information on how contextual factors shaped the two students' (Emanuael and O'Tanya) use of science discourse and social identification over time. Brown's (2004) work also leaves readers to conjecture about the relative flexibility or rigidity of these different classroom statuses. Brown's (2004) research does not move beyond identifying the different possible classroom identities to show how they develop through interaction. In this study I aim to avoid this gap in understanding by analyzing classroom discourse and social identification across two dimensions: the local norms for how students articulate successful science student identities (Research Question 1, Chapter 4), and the pathways of social identification and learning of three focal participants (Research Question 2, Chapter 5).

2.2 Language Socialization Research

The following subsections describe approaches to L1 and L2 socialization research, socialization pathways, and academic discourse socialization. The section continues by reviewing literature on expertise as an interactional accomplishment, and by relating language socialization research to Third Wave sociolinguistics. The section concludes by demonstrating the need for more research on peer language socialization in classroom settings, and in K-12 science education contexts in particular.

2.2.1 Language Socialization Research in L1 Settings

Ochs and Schieffelin (2008) trace the origin of Language Socialization (LS) research to Slobin's (1967) publication of *A Field Manual for Cross-Cultural Study of the Acquisition of Communicative Competence*. According to Ochs and Schieffelin (2008) linguists, anthropologists, and psychologists contributed to the handbook, which drew on Dell Hymes' notion of communicative competence (Hymes, 1972) and John Gumperz's construct of a "speech community" (Gumperz, 1968, as cited in Ochs & Schieffelin, 2008). This handbook provided the initial framework for the Ethnography of Communication (EofC) genre of research (Ochs & Schieffelin, 2008).[4] Early LS studies focused on first language acquisition and showed that linguistic, social, and cultural factors shaped children's development of communicative competence (Ochs & Schieffelin, 1984, 2008).

Reflecting on their own seminal work (Ochs & Schieffelin, 1984), Ochs and Schieffelin (2008) claim that they "proposed that the process of acquiring language is embedded in and constitutive of the process of becoming socialized to be a competent member of a social group and that socialization practices and ideologies impact language acquisition in concert with neurodevelopmental influences" (p. 5). Ochs and Scheffelin (1984) demonstrated this by comparing three "developmental stories" that described the differing language socialization practices of middle to upper-class White Americans, Somoans, and Kaluli speakers in Papua New Guinea. Ochs and Scheffelin (1984) challenge the notion of a dichotomy between knowledge of linguistic code and sociocultural knowledge. Their approach does not deny that children are biologically

[4] Saville-Troike (1982) attributes the beginning of EofC to Hymes's 1962 publication of "The ethnography of speaking." In both researchers' assessments, Dell Hymes's work laid the foundation for this type of ethnography.

predisposed to acquire language however; it places the locus of research on cognition as social practice as opposed to cognition in isolation.

In addition to Ochs and Schieffelin's (1984) comparison of three different developmental stories, seminal works in the field of L1 socialization in the United States include Heath's (1983) *Ways with Words*, which compared the language and literacy socialization practices of community members in Roadville and Trackton, in the Piedmont Carolinas, and Philips's (1983) *The Invisible Culture*, which explored differences between the language practices on the Warm Springs Reservation and in the surrounding predominantly Anglo community. Heath's and Philips's ethnographies recount the difficulties experienced by minority students in school as a result of differences in the expectations for language use between students' home and school communities and cultures. These cases reveal the struggles of monolingual English-speaking students in developing bicultural proficiency and the associated linguistic practices (repertoires) that were necessary for academic success.

Bilingual students who come to school with home languages other than English may experience similar discontinuities between their home cultures and school culture (Lee & Fradd, 1998). The insight into the communicative practices on the Warm Springs reservation and in the surrounding community, and in Roadville and Trackton could not have been collected without the ethnographic work that is foundational to LS studies. This ethnographic work crucially reveals how linguistic practices are co-emergent with cultural practices.

2.2.2 Language Socialization Research in L2 Settings

Although Philips's and Heath's ethnographies document the challenges of L2 users of academic English and its communicative patterns, applied linguists and linguistic anthropologists have also studied L2 English discourse socialization by non-native speakers of English. Duff (1995) conducted an EofC, which she also identified as a language socialization study. Duff (1995) compared the communicative practices in English medium (immersion) history classes in Hungary and traditional Hungarian history classes. Duff (1995) contextualized her study by relating microlevel discourse changes within classrooms to the larger, macrolevel political and cultural changes that were occurring at the time. Duff (1995) focused her investigation on the speech events of *felelés*, which are recitations by individual students who are called on at random by the teacher to demonstrate their understanding of the prior day's lesson. Duff's (1995) work provides an example of how sociopolitical forces within a country can shape the language socialization paths of students in affected programs. The students in the English medium classes that Duff (1995) describes who did not use *felelés* learned not only how to express their conceptual knowledge of Hungarian history in English, but also a new set of values about the ways that people learn and how that learning should be evaluated, rules for interacting with teachers and authority figures, and other cultural notions.

Duff (2002) also conducted an EofC in a diverse mainstream Canadian social studies classroom that contained both native (local) and non-native English speakers (nonlocal). Duff's (2002) work reveals three important points about L2 language socialization in schools. First, Duff (2002) showed that turn-taking patterns, allocations of turns, and seating arrangements influenced students' quantity and type of talk; nonlocal students participated quietly and with shorter turns than local students despite being stronger students academically based on written assessments. Second, Duff (2002) challenges the inevitability that is often assumed in socialization research. She claims that her, “observations revealed that the non-local students’ interaction patterns during class discussions did not change markedly over the year, and students like Mark and Bradley who had been in Canada for nearly a decade didn’t participate like Pam or Janet or other local classmates” (p. 314). Third, Duff (2002) found that students’ accented speech created a clear linguistic and social barrier between the two categories of students found in the class. By applying Wortham’s (2006) terminology to Duff’s (2002) ethnography these two positions, local and nonlocal, could potentially be described as salient identity models in this classroom.

Miller and Zuengler (2011) document an example of how one ELL’s resistance to classroom practices was co-constructed with the teacher and other students in a sheltered instruction civics class. Miller and Zuengler (2011) show how May became a “mouthpiece” for other students in the class as they reconstructed her contributions to classroom discourse to meet their own agendas (in this case, avoiding a particular assignment). Miller and Zuengler (2011) argue, “May learned her Hmong-based peripheral/marginal participation was preferable to attempting to participate in the English-language component of classroom practices” (p. 144). This case provides another example of how a student’s classroom identity as quiet and resistant emerged as a result of classroom interactions.

Harklau (2003) showed how immigrant students’ identity development in their U.S. high school classes were shaped by three widely circulating narratives about immigrants in the school: the colorblind representation, the Ellis Island immigrant representation, and the linguistic deficit representation. Harklau (2003) shows how one teacher used curricular resources (writing assignments) to encourage students to articulate their experiences as immigrants in terms of the Ellis Island representation. Harklau (2003) argues that the essentialized representations this led to encouraged students to view themselves as "perpetual foreigners who were primarily exemplars of ethnolinguistic identities and only secondarily individuals" (p. 90).

In addition to these school-based L2 socialization studies, Garrett and Baquedano-López (2002) identify a number of language socialization studies that were conducted in nonschool bilingual and multilingual settings (e.g., Baquedano-López, 2000; Garrett, 1999; Meek, 2001). These studies show critical connections between socialization practices and identity, and they provide cases documenting the emergence of language variation and change. Although the school-based L2 socialization studies in ESL and mainstream classes provide examples of academic discourse socialization on a broad scale, none of the studies cited above related these processes of socialization to students' development of discipline-specific linguistic repertoires and disciplinary identities.

Before moving on to discuss examples of academic discourse socialization, it is prudent to explore how L2 socialization studies fit into the broad spectrum of SLA research and to justify further the need for a *trajectories* or *pathways* approach to studying socialization processes. Duff and Talmy (2011) claim that while second language socialization research shares theoretical constructs and methods with other approaches (e.g., conversation analysis, themes of identity and power, and sociocultural, sociocognitive, and ecological approaches to SLA), LS research is in fact distinct in its approach to studying language acquisition. Duff and Talmy (2011) summarize the differences as follows:

> These differences include the use in language socialization of anthropological methods, as well as its orientation to *enculturation* – i.e., not the accumulation of linguistic knowledge or communicative competence alone. Thus, whereas many recent social accounts of language acquisition conceive of it as the intersection of *social* and *cognitive* processes, often giving a privileged status to the linguistic forms that are acquired by learners in the context of social interaction, language socialization places a greater premium on the *social* and the *cultural* in psychological experience, including language learning. (p. 110)

This quote reiterates the points made in Section 2.2, that LS research moves beyond a cognition in context approach, that theorizes cognition as having some separable properties, to a view of cognition as inextricable from social practice. I reiterate this point again with such heavy-handed emphasis because this view departs from the assumptions of some psycholinguistic and experimental SLA research.[5]

2.2.3 Socialization Pathways

The *pathway* or *trajectory*-based approach that I advocate for in this dissertation moves "beyond the speech event" (Wortham, 2005). Wortham (2005) argues that in order for researchers to understand how some students in a classroom become positioned as smart or hardworking and others as lazy or unintelligent, language socialization researchers need to move beyond a focus on speech events and towards a focus on students' individual identity trajectories. Wortham (2005) claims:

> …to focus only on recurrent events would be to miss the indeterminacies and complexities of how individuals move across specific trajectories and how events in a trajectory are linked. Socialization, as an inherently intertextual process, must be studied in part by examining links among events across time. (p. 95)

[5] Atkinson (2011) traces the emergence of the cognitivist (positivist, experimentalist) tradition in SLA research and documents some of the assumptions of this type of research.

I discuss how Wortham and Reyes (2015) advocate for researchers to conduct pathway based socialization research in Chapter 3.

In their discussion of future directions in language socialization research in SLA, Duff and Talmy (2011) claim that more research must be conducted to explore the "unpredictability, contestedness, and fluidity of socialization, as it is or is not achieved" (p. 111). The *pathways* approach developed by Wortham (2005, 2006) and Wortham and Reyes (2015) provides a framework to accomplish the type of study advocated for by Duff and Talmy (2011). In order to help teachers facilitate language and content learning and to create equitable classrooms, researchers must discover how teachers and students work (perhaps inadvertently, perhaps intentionally) to position certain students as successful or unsuccessful.

In this dissertation I focus on the practices involved in a particular cultural and linguistic event, scientific inquiry, but in order to understand how students become successful or unsuccessful practitioners of scientific inquiry, I partner my exploration of inquiry as a social and linguistic practice with a focus on three students' identity trajectories across multiple inquiry events.

2.2.4 Academic Discourse Socialization

Academic discourse socialization is a subfield of LS research. Duff (2010) claims that despite a large body of research on academic discourse as an object of study, little research has yet explored how students come to be proficient users of academic discourses. Thus, Duff (2010) outlines three questions that frame the field of academic discourse socialization research:

1. How do newcomers to an academic culture learn how to participate successfully in the oral and written discourse and related practices of that discourse community?
2. How are they socialized, explicitly or implicitly, into these local discursive practices?
3. How does interaction with their peers, instructors, tutors, and others facilitate the process of gaining expertise, confidence, and a sense of authority over those practices over time? (p. 169)

Researchers address such questions using the theoretical tools from the fields of sociolinguistics, education, sociology, cultural psychology, and linguistic anthropology (Duff, 2010). The questions listed above relate to Lemke's (2000) question, "How do *moments* add up to *lives*?" (p. 273). Lemke (2000) argues that in order to answer such questions, "it takes a village to study a village" (p. 288). Thus, the variety of theoretical frameworks and research methods that may be used in LS research represent the "village" of frameworks that are needed in order to understand interconnections between language, cognition, and social life, and how individuals' moment-to-moment experiences lead them from novice to expert or from legitimate peripheral participation to full participation (Lave & Wegner, 1991). In this dissertation I view academic discourse through the lens of interaction as opposed to defining academic discourse as identifiable by a predetermined set of linguistic features.

Duff (2010) argues that oral academic discourse socialization studies have "been the most neglected in studies of academic discourse" (p. 177). In addition, many of these studies focus on undergraduate and graduate students' socialization into particular fields or practices within those fields. For example, Jacoby (1998) studied the socialization of physics graduate students and postdocs into the academic discourse of conference presentations during rehearsal presentations; Vickers (2007) focused on discourse socialization in an engineering design project, and Bucholtz et al. (2011, 2012) investigated undergraduate science identity formation in a chemistry lab and a calculus work group. In addition to the studies cited above, Duff (2010) also cites a small amount of academic discourse socialization research at the K-12 level (e.g., Beckett 2005; Duff 1995, 2002; Maybin 2003). Although I address additional studies from science education in the following section, it is important to recognize the dearth of research in this area.

Duff (1995, 2002, 2008, 2010; Duff & Talmy, 2011) has dedicated much of her career to L2 socialization research. Yet even with her vast background, she struggled to find studies of oral academic discourse socialization for her 2010 article in the *Annual Review of Applied Linguistics*. This dissertation, which explores science classroom discourse socialization with bilingual learners, adds to the growing body of research in this relatively new field. This work is of general value to educators working with language learners in science classes and to applied linguists interested in disciplinary language learning.

2.2.5 Science Discourse Socialization

The studies discussed here stem largely from the field of science education as opposed to the largely applied linguistics research cited in the previous section. Bryan Brown and his colleagues (Brown, 2004, 2006; Brown et al., 2005) explore the impact of science classroom identity development on students' development of scientific literacy and present a framework for analyzing these relationships, which they term, discursive identity. Brown et al. (2005) draw on research by many of the same theorists described earlier (e.g., Gee, Wortham, & Lemke), but they develop an approach to analyzing science classroom discourse that differs from the approach used in this dissertation.

While Brown et al. (2005) apply their theoretical framework to a data set from a fifth-grade science classroom in order to demonstrate the types of understandings that can be gained from using the framework, their analysis focuses more on the content of *what* is said than on the social context that such uses of language construct and reflect. As a result, the subtle social positioning between students and the multiple layers of identity that influence interaction go unaddressed. For example, in one excerpt from this study, the teacher is reported as saying, "He used that word "categories," so something's different. They got to come together in groups in order to be studied" (p. 792). Why does the teacher say "got to" instead of, "gotta," or "have to" in this conversational turn? Is the teacher signaling a more casual register and with it expectations for how students should talk about science in this context? The discursive identity framework that Brown et al. (2005) present does not have the tools to answer such questions. However, it is questions like these that are important to ask when exploring how students become socialized to take up or reject particular classroom identities. Much can be gained by using the discursive identity framework; however, studying students' identity trajectories over time requires a finer grained analytical tool kit.

A number of science education scholars who study science classroom socialization or science identity development use ethnographic methods. Cole and Zuengler (2003) used a language socialization framework to explore how students in a freshman biology class in a magnet track at an urban public school in the United States resisted and denied science identities as a result of their participation in an authentic scientific study. Cole and Zuengler (2003) describe four local identity models[6] that emerged in this classroom over the course of the year—the good student versus not good

[6] I use Wortham's (2006) terminology here; Cole and Zuengler (2003) do not.

enough student, the scientist-researcher, the ghetto school student, and the child laborer. Cole and Zuengler (2003) show how the scientific practices (e.g., data processing) and social roles (e.g., child laborer) available to the students as they participated in a large-scale scientific study, the Asthma Project, resulted in some students' disaffiliation with science. The authors attribute student disengagement to a variety of constraints on the full participation of students in the scientific study. Crucially, this project revealed that engaging in actual scientific research does not inherently provide students with the opportunity to be apprenticed into a community of scientists. Constraints on how students were allowed to participate in the project influenced the identity stances they constructed in their high school biology classroom.

Additional research on discourse and socialization in science classes comes from the work of Angela Calabrese Barton and Edna Tan who conducted a longitudinal ethnographic case study of African American and Latina girls in science classrooms (Barton & Tan, 2009; Basu & Barton, 2007; Tan & Barton, 2008a, 2008b, 2010). These studies reveal ways that a teacher might incorporate students' funds of knowledge into a sixth-grade science curriculum to promote the creation of hybrid discourses (Barton & Tan, 2009), the tracking of how one Dominican girl moved from being a low performing to a high performing science student over the course of 1 year (Tan & Barton, 2008a), and how two Latina students authored identities in practice, which challenged the way that teachers and researchers should think about science for all (Tan & Barton, 2008b). Again, though this research adds critical information to the larger body of research on how students are socialized into or out of science identities, the methods used in these ethnographic accounts do not explore the subtle positioning that students undergo in moment-to-moment interaction.

2.2.6 Expertise as an Interactional Accomplishment

In order to answer the questions posed by Duff (2010; listed in Section 2.2.4) about how students develop expertise in academic discourses, it is necessary to cultivate an understanding of expertise as an interactional accomplishment as opposed to a body of knowledge. In his summary on the state of research on expertise in anthropology, Carr (2010) claims that “expertise requires the mastery of verbal performance, including – perhaps most importantly – the ability to use language to index and therefore instantiate already existing inner states of knowledge” (p.19). Carr demonstrates this point by reviewing descriptive accounts of the development of expertise and by discussing four interconnected themes that emerged from his review. First, Carr demonstrates that people become experts by forming asymmetrical relationships with people and things and by learning to communicate their knowledge of and perspective on these things authoritatively. Second, Carr demonstrates that expertise is a collaborative endeavor requiring the participation of others on a routine basis. Third, Carr discusses expertise as an institutional product whereby institutions organize the authentication of experts (e.g., universities conferring degrees). Lastly, Carr discusses how something that is collaborative and institutionally organized comes to be understood as a property possessed by expert individuals. In other words, how verbal skill and linguistic performance come to serve as a proxy for demonstrating knowledge about a topic.

Rifkin and Martin (2004) demonstrate the central role of verbal performance in the construction of expertise in a water board hearing and show how linguistic strategies for shaping discourse and interaction led one of two competing experts to be seen as a more believable expert. The designation of one expert as more expert than the other did not rest on the experts' interpretations of scientific facts but rather how they positioned themselves socially during the water board hearings. As a result of his review, Carr (2010) suggests that fruitful lines of inquiry into the development of expertise as a cultural process should ask, "what are the semiotic processes by which expertise is realized and what cultural and linguistic resources are deployed in this inherently improvisational, interactional, and institutional work?" (p.27) This dissertation offers one answer to this question.

Learning academic language is as much a process of learning grammar as it is a process of learning to identify oneself as a particular social type (Agha, 2007; Wortham, 2006). In order to identify the language practices students must learn in order to be perceived as experts in their classrooms, we must look beyond referential semantics and isolated syntactic constructions to how talk is organized among peers when students engage in scientific inquiry. The process of being recognized as a science expert relies on a student's ability to deploy a set of communicative resources that taken together come to index that identity.

2.2.7 Language Socialization and Third Wave Sociolinguistics

A discussion of how language use both reflects and creates social identities is incomplete without a discussion of *Third Wave* sociolinguistics research. Gumperz and Cook-Gumperz (2008) claim that the fields of linguistic anthropology and sociolinguistics are moving away from a focus on communities and towards a focus on identities. Embedded in this shift is the idea that people have multiple identities that emerge and recede through interaction as the social context demands. Eckert (2012) defines three waves in sociolinguistics that move from the use of macrosociological factors (for example, race, class, gender) to explain sociolinguistic variation (first wave), to ethnographic approaches to understanding variation that acknowledged the fluidity of peoples' memberships in different communities and, thus, the fluidity of language use across social contexts (second wave), and finally towards an understanding of sociolinguistic variation that views individual features of language as resources for indexing social meaning in moment-to-moment interactions (third wave).

This movement over three waves of sociolinguistics carries with it transformations in the notion of identity. In the first wave, identities are reduced to macrosociological categories, in the second wave the category labels exist, but people are seen as having multiple independent identities. In the *Third Wave* identity is seen as fluid, co-constructed via social interaction, and thus bound to particular interactions as opposed to being bound to a setting or to a physical characteristic of a speaker. Although Eckert's (2000, 2012) primary goal as a sociolinguist is to uncover and describe mechanisms of language change, the tools for linking language and identity that she and others (e.g., Bucholtz, 2011; Mendoza-Denton, 2008) use for this purpose can also be applied to investigating how students and teachers construct local linguistic repertoires using various linguistic resources.

Bucholtz and Hall (2008) claim that researchers "need to start with what people are accomplishing interactionally and then build upward to the identities that thereby emerge" (pp. 153-154). Bucholtz and Hall (2008) also claim that "identity work is a highly politicized process in which social actors claim, contest, and negotiate power and authority" (p. 154). Student and teacher identities shape classroom discourse and are shaped by them through their deployment of linguistic resources in microlevel interactions that are influenced by individual agency, and macrosociological factors (Rymes, 2009). One might think of this study as an exploration of how second language and bilingual learners either develop or resist (consciously or unconsciously) developing the sociolinguistic competence necessary to navigate the cultural practice of inquiry in one science classroom.

2.2.8 Peer Language Socialization

Classroom discourse research that addresses student identity development often centers on contexts in which teachers are directly controlling participation in classroom tasks. These settings may be whole class discussions (e.g., Brown, 2004, 2006; Brown, Reveles & Kelly, 2005; Hanrahan, 2006; Wortham, 2006) or small group discussions with the teacher present (e.g., Rymes & Anderson, 2004). In contexts in which the teacher is present or directly guiding interaction, it is possible to see the teacher communicate explicitly and implicitly values related to what it means to be a "good ______ student" (where the blank is filled in with the discipline, e.g., science, history, etc.). Teachers relay information to students about how to be successful in their classrooms through many behaviors such as enacting "participant examples" (using analogies between students in the class and fictional people in the curriculum; Wortham, 1994; 2006), and commenting explicitly on students' performances (Brown, Reveles & Kelly, 2005). Ginsberg (2015) used ethnography and a multimodal semiotic approach to discourse analysis to identify (among other things) the practices of the "good math student" during whole class discussions. While whole class discussions provide important opportunities for teachers to communicate school and discipline specific values to their students, they also provide a platform for students to then articulate classroom identities.

However, when the teacher is present, the teacher serves as the resident content-matter expert. Thus, in interactions with the teacher it is more likely that students will perform good student identities than expert identities. For this reason, Heath and Street (2008) advocate for ethnographic research that examines contexts in which students are able to take up expert roles. Although Heath and Street (2008) discuss settings other than schools for these investigations, I argue in this dissertation that classrooms that contain a significant portion of time spent in small groups also offer an important context for students to develop expertise. The work of the scholars mentioned here provides insight into the ways that students and teachers negotiate social roles and learning during direct instruction. However, in classrooms that include significant amounts of time where students work in small groups (such as the classroom that is the focus of this dissertation), teacher-directed lessons are not the only contexts in which students develop discipline-related identities. Studies of disciplinary identity development that focus only on teacher-directed instruction and exclude peer interaction fail to address a salient domain for students' disciplinary identity work.

Notable exceptions to the trend to focus on teacher directed classroom discourse at the K-12 level include Wortham's (2008) analysis of a middle school lab group, and Kameberelis and Wehunt's (2010) analysis of two fifth-grade students' discussions while engaging in a science lab and writing a lab report. Although valuable in demonstrating some of the social dynamics that students engage in while "doing" science, neither of these case studies emerged from long-term ethnographic fieldwork in the classroom communities from which they were drawn. As a result, while Wortham's (2006) detailed account of student socialization describes multiple emergent local identity models (e.g., the outcast, the good student), the descriptions in Wortham (2008) and Kamberelis and Wehunt (2010) are not deeply contextualized within the local classroom culture and therefore cannot connect students' interactions to more enduring classroom identities. As teachers are increasingly taught to provide all students with opportunities to work in groups to facilitate their content and language learning, it has become even more important to understand how social dynamics shape students' discussions, collaborative learning, and disciplinary identity development.

Research at the undergraduate level demonstrates the importance of peer socialization in students' disciplinary identity work. Bucholtz, Skapoulli, Barnwell and Lee (2011) found that students in a calculus working-group for science majors used entextualized humor (circulating formulaic math and science jokes) to articulate scientist identities. Students in the group who did not partake in circulating these jokes were seen as less scientific than their jokester peers. In addition, Bucholtz, Barnwell, Skapoulli and Lee (2012) found that two girls in a chemistry lab positioned their male lab partner as less competent than them through repeated teasing and other stance taking over the course of a semester. Bucholtz et al. (2012) trace the emergence of Bill as a less scientific student, as a result of the interactional positioning instigated by the female lab partners who considered themselves to be science people.

Lastly, two studies in engineering education demonstrate the importance of attending to peer group socialization when exploring disciplinary identities. Vickers (2007) traced the participation of Ramelan, an international student who was also an English Learner, in an engineering design project over the course of 1 school year. Vickers (2007) applied Lave and Wenger's (1991) socialization paradigm in her context and identified four possible identity positions for participating students: inner core, outer core, inner periphery, and outer periphery. These positions sit on a continuum from full to peripheral participation (respectively). Vickers (2007) found that asking and answering technical questions was the most salient communicative practice distinguishing students along this continuum.

> In the ECE team meeting, questions are not associated with the talk of the more expert interlocutor. The information seeking is typically done by the novice interlocutor. The expert interlocutor is the one to explain information, playing the role of information-giver and controlling topics of conversation, which is important to the interactional achievement of the identity of a competent engineer. (Vickers, 2008, p.630)

This quotation demonstrates the centrality of technical explanations and questions, and controlling topic in the formation of an engineer identity. Vickers (2007) found that as Ramelan moved from asking nontechnical to more technical questions, he moved from the outer periphery to the inner periphery of his design group (closer to core membership).

O'Connor (2003) found that undergraduate students in a design project collaborating between two universities were unable to overcome the stigma against practical experience as relevant expertise in their engineering design group. The students from the technical school became positioned as less knowledgeable than the students from Institute (a school with a local reputation for academic excellence) as a result of Institute students' criticisms of and challenges to the expertise of project advisors.

Bringing the two groups of students together reinforced rather than challenged the social hierarchies present outside of the two schools. As a result the students with practical experience were seen as less expert than students attending the more prestigious school, which was the opposite of the goal of the project. These examples from undergraduate STEM education demonstrate the importance of peer interactions in shaping students' affiliation and disaffiliation with STEM disciplines and identities.

2.3 Characteristics of Classroom Discourse

Although I have just made the case for focusing on peer interaction, examining the characteristics of teacher-controlled classroom discourse provides background for researchers to identify relevant questions and phenomena to investigate in peer-based classroom discourse studies. Just as Section 2.2 recounted language socialization studies, some without fine-grained discourse analysis, there are discourse analysis studies that do not employ ethnographic methods. However, all classroom discourse research sheds some light on the socialization processes occurring in various classroom events. Classroom Discourse Analysis (CDA) studies are often also *critical* in that they seek to reveal how power differences are constructed in classrooms and the implications that these have on classroom learning.

CDA provides teachers and researchers with a tool to analyze the language that is used in classrooms to identify ways to improve instruction (Cazden, 1988, 2001; Edwards & Westgate, 1994; Gallas, 1995; Rymes, 2002, 2009). These improvements range from increasing participation by changing the dynamics of whole class discussions (Gallas, 1995), to scaffolding students' language use to move them to using a more formal register (Gibbons, 2003), to adjusting the expectations for the types of language use that count as valid contributions to class discussions (Cazden, 1988, 2001). CDA studies also reveal the ways that students' oral language practices relate to the written texts that they produce (Kamberelis & Wehunt, 2012). In addition, CDA studies have also been used to explore the socialization of young learners during literacy events (Rymes & Anderson, 2004; Rymes, 2003).

Two relevant themes must be reiterated here before continuing this discussion of CDA research. First, the notion of power/knowledge (Foucault, 1980) discussed in Section 2.1 becomes particularly salient when we consider the preceding body of work. When teachers change interactional patterns and expectations for talk in their classrooms to promote participation, this is inherently a move to redistribute power in the classroom. CDA researchers vary in the degree to which they explicitly discuss power relationships (e.g., Gibbons, 2003, discusses bridging to a formal register as a linguistic move, and she does not address the power dynamics that are involved in such a move); however, it is essential to recognize that power relations are always at play in interactional discourse data. Second, the goal of creating a third space or hybrid discourse emerges in much CDA research (Barton & Tan, 2009; Duff, 2004; Hanrahan, 2006; Kelly, 2012; Moje, Collazo, Carrillo, & Marx, 2001). Hybrid discourses[7] are created by blending ways of speaking (repertoires) from various areas of life with academic ways of speaking and knowing. Often, the purpose of creating hybrid discourses is to help students build bridges between ways of knowing and speaking outside of school and those promoted in school. Gee (2005) suggests that this is problematic in the sciences where everyday ways

[7] Hybrid discourses, blurred discourses, and blended discourses are all terms that may also be used to refer to multimodal texts (Duff, 2010). I use the term consistently in this dissertation to refer to the definition included above.

of speaking simply cannot express the level of detail needed to convey scientific understandings (a point also reiterated in the vignette from Brown 2004 discussed in section 2.1.3). Nevertheless, researchers look for places to foster hybridity. This leaves us with the question of how students employ and value hybridity during peer interaction. For example, for what purposes do bilingual students code-switch during science labs and what are the local social consequences of code switching on students' development of science expertise? I do not address this question directly in this dissertation but the findings presented in Chapters 4 and 5 touch on this larger issue.

2.3.1 Cross-Disciplinary Features of Teacher-Led Classroom Discourse

Although some aspects of school culture are unique, the history of public education and schools as institutions of the state has lead to features of schooling as a social practice that transcend the boundaries between individual schools and classrooms. Lemke (2000) maintains that while constituents in a larger system (e.g., individual schools) have individual properties, they are still in many ways typical of the larger system that produced them. Patterns in turn-taking, strategies for getting the floor, strategies for holding the floor, and questioning, as well as methods of praise and censure, emerge in particular ways in classrooms (Cazden, 2001; Rymes, 2009). In addition, classrooms contain certain speech genres, for example sharing time in elementary school (Cazden, 2001) and science fair presentations at the secondary level, which contain similar features across different classrooms. I will briefly describe two of the features of classroom discourse described by Cazden (2001): "speaking rights and listening responsibilities" and teacher questioning practices. Cazden (2001) and Rymes

(2009) advocate for teachers to attend to these features of discourse so that they are able to create more equitable learning environments for their students.

Cazden (2001) begins her discussion of speaking rights by pointing out the asymmetry in power between teachers and students with respect to who is allowed to speak and when. Teachers, by virtue of their institutional authority, are allowed to address any person in the classroom at any time, while students are expected to speak only during teacher-sanctioned moments. As a result of these expectations for who speaks when, students are expected to raise their hands in order to get the floor. In teacher-dominated classrooms, certain students often participate more than others with some students successfully avoiding verbal participation in class for days. Cazden (2001) provides suggestions for how teachers can try to reshape these expectations, for example preallocating turns and stepping back from the conversation, and with older students, avoiding calling on certain students who frequently dominate classroom conversations. Cazden (2001) also advocates for showing students a videotape of a classroom conversation so that they became aware of the patterns the teacher is trying to change. Each of these strategies aims to increase the levels of participation from traditionally non-participatory students. Gallas (1995) recounts how she changed the speaking rights during science talks in her kindergarten class so effectively that when her student teacher tried to participate in a science talk by setting the agenda for the talk, a student responded, “but these are our talks!” (Gallas, 1995, p. 22). This example shows that is it possible for teachers to change these rights in particular contexts. This review of speaking rights in teacher-led discourse again leaves us with an unanswered question related to peer interactions. What are the rules of engagement in small group discussions? How do students manage participation in a science lab when the teacher is not directly involved in interaction and has not made clear the expectations for how to collaborate? Again, though this research does not directly address this question, the results of this case study do bear on this larger question in classroom-based language socialization research.

Teacher questioning patterns and turn-taking have also been the subject of much CDA research (e.g., Rymes & Anderson, 2004). Mehan (1979) is often attributed with the first description of initiation-response-evaluation (IRE) questioning patterns in classroom discourse. Although the consequences of this sequence are codependent on the teacher's posing of a known answer versus an unknown answer question, IRE sequences often result in a T-S-T-S-T-S (where T represents a conversational turn by the teacher and S represents a conversational turn by a student) style of discourse. Teachers' evaluations of student comments can have dramatic impacts in their classroom identities. Rymes and Anderson (2004) showed how a teacher's use of a known answer question and her dismissive response to a student's answer (which she perceived to be off-topic) during a small-group reading task led the student to not participate in future small group reading discussions. In another example, Carlone et al. (2011) found that the African American and Latina students, who disaffiliated with the smart science student identity (despite high levels of skill and interest in science), did so as a result of their disinterest in displaying their knowledge to the teacher via answering known answer questions correctly during class discussions. Students' responses to the questioning patterns in a classroom or in a particular type of lesson help to construct local identity models. Despite the value of these studies in revealing how teacher-controlled practices shape opportunities for diverse students to participate in class discussions, teacher-led discussions are only one type of activity in modern-day classrooms. These accounts of teacher evaluation leave us with the question, how do students evaluate each other's ideas and suggestions during a joint task and what types of students emerge as experts when the teacher is not present?

2.3.2 Science Discourse

While research on *science discourse* is broad in its disciplinary roots and appears as early in history as the scientific revolution itself (Latour, 1999), research on *science classroom discourse* has a relatively shorter history. Due to the ease with which written texts can be collected and analyzed, it is unsurprising that most work focuses on written as opposed to oral texts. In addition to specific grammatical resources, Lemke (1990) provides nine rules of science classroom discourse:

1. Be as verbally explicit and universal as possible.
2. Avoid colloquial forms.
3. Use technical terms in place of colloquial synonyms.
4. Avoid personification.
5. Avoid metaphoric and figurative language.
6. Be serious and dignified and avoid sensationalism.
7. Avoid references to personalities and reference to individual human beings.
8. Avoid reference to fiction or fantasy.
9. Use causal forms of explanation and avoid narrative and dramatic accounts. (p. 133)

Rather than advocating for the use of these rules, Lemke (1990) provides evidence that students find these discourse strategies to be alienating, and he devotes an entire chapter of his book to what he calls "teaching against the mystique of science " (pp. 129-151). At the outset of this dissertation research it was unclear how if at all students would orient to these features in their small group discussions during lab tasks.

2.3.2.1 Grammatical Constructions

In his description of science language, Zwiers (2008) cites two grammatical constructions as having unique uses in science classes: the use of the present tense to describe how and why particular phenomena occur, and the use of passive voice, which removes scientists as the agents of data construction. I add to this, the use of conditionals in order to formulate hypotheses.

Mary Schleppegrell and her colleagues (Schleppegrell & Achugar, 2003; Schleppegrell, 2004; Schleppegrell, Achugar, & Oteíza, 2004; Schleppegrell & Colombi, 2002) working from the field of Systemic Functional Linguistics (SFL), provide additional resources for understanding the grammatical constructions present in the science (and other disciplinary) texts that students read and write in school. M.A.K. Halliday founded the field of SFL which entails an approach to describing grammatical constructions with respect to their communicative functions (Halliday, 1994; Halliday, 1975). Using SFL, Schleppegrell (2004) found, "a pervasive feature of academic and scientific texts, nominalization is the expression as a noun or a noun phrase of what would more naturally in spoken interaction be presented in another form" (pp. 71-72). Schleppegrell (2004) compares, "the telephone was invented" to the nominalization, "the invention of the telephone". Because Schleppegrell cites nominalization (and grammatical metaphor) as a part of academic written discourse and as being used often in science texts, it seemed possible at the outset of this study that students and the teacher would use some nominalizations when speaking to construct local identity models related to expertise.

Further evidence for the possibility of nominalizations being important grammatical features for this study came from the work of Massoud and Kuipers (2008) and Viechnicki (2008). These two papers come from a special issue of *Linguistics and Education,* with the theme of the objectification and the inscription of knowledge in science classrooms. Drawing on the work of Halliday and Martin (1993; as cited in Massoud & Kuipers, 2008), Massoud and Kuipers (2008) define objectivity as "the act of representing a process, action, or relation as an object or thing" (p. 212), and they proceed to conduct an ethnography of objectification. They identify two grammatical resources that students and the teacher use to objectify processes and actions: nominalizations (e.g., the invention of the telephone, hornworm growth) and the resemiotization of verbal objects (e.g., the noun phrase *change in mass* losing its connection to the particular process that caused a change in mass).

Like Schleppegrell (2004), Massoud and Kuipers (2008) note the importance of nominalizations in scientific texts by stating that, "some might go so far as to argue that nominalization is a defining characteristic of scientific writing and scientific thought" (p. 215). They further argue that the "nounifying or thingifying process of nominalization disguises its own agency—where it came from, who made it, how it came to be" (p. 215). This removal of the agency of the scientist in creating data leads to the reification of scientific knowledge as facts about the natural world. If we think about the purpose of scientific research, which is to describe and make predictions about the natural world that if correct stand the test of time, the use of nominalizations is an effective strategy to build a body of objective science knowledge.

In addition to this description of the use of nominalizations in science, Massoud and Kuipers (2008) also explain the process of verbal objectification via resemiotization.

The authors claim that, “when verbal objectification occurs, the process whereby the verbal object was constructed fade over time in the communication between persons interested in the object” (p. 217). For example, when students observe a gas being produced via a chemical reaction in a beaker and the teacher labels this process as gas drawing students’ attention to this object, students may over time come to see similar processes in terms of the object produced without actually coming to recognize the process.

2.3.2.2 Formulaic Expressions

Research on formulaic expressions from corpus linguistics (i.e., the use of corpora or large samples of texts to identify commonly occurring phrases) reveals a number of structures that are frequently used in scientific journal articles (Kermes & Teich, 2012). Kermes and Teich (2012) found that, “generally speaking, scientific language seems much more formulaic than general language” (p. 109). Hermes and Teich (2012) also found variation across various disciplines of science (e.g., engineering, biology, etc.). However, research by Egbert (2013, 2014) also demonstrates that the types of formulaic expressions present in science texts vary across the types of texts studied: science textbooks, popular science texts, and journal articles. Although there are no corpus studies of oral science texts that demonstrate the use of formulaic language, Bucholtz et al. (2012) demonstrated how students used an unexpected formulaic resource (science jokes) to signify scientist identities. Thus, we may expect to find various types of formulaic language figuring in identity construction in science classes.

2.3.2.3 Science Vocabulary

Scientific vocabulary and the lexical density of these terms in texts (Schleppegrell, 2004) are features of science discourse. Gee (2005) argues that using everyday language to explain scientific phenomena inherently carries with it the blurring of conceptual lines that science tries to draw in part because of the specific vocabulary of the sciences. The excerpt of classroom talk from Brown's (2004) classroom listed in Table 2.2 provides an example of this. When Emmanuel switches to a less formal register to explain a scientific process, he uses fewer lexical items with specific scientific meanings and is subsequently unable to provide an accurate description of virus replication. In addition, it is important to note that the curriculum in a science class can promote specific scientific uses of everyday terms (Viechnicki, 2008). Viechnicki found that one particular curriculum promoted specialized uses of the terms *weight*, and *to weigh*.

2.3.2.4 Epistemic Stance

Schleppegrell (2004) discusses authoritative stance as a feature of written science texts. Because this dissertation focuses on how students negotiate science content and language while also constructing social roles for themselves, it is relevant to review some basic literature on epistemic stance. Rymes (2009) provides a table summarizing various affective and epistemic stance markers. People construct epistemic stance in conversation; in part they do this through use of factive verbs such as *know, think*, and *remember*. Kärkkäinen (2003) provides an account of *I think* as a frequently used epistemic stance marker in English. However, stance is also constructed through using high and low certainty adjectives (e.g., *possible, supposed, unclear*) modal adverbs (e.g., *probably, always*), modal verbs (e.g., *can, may, must, could*), discourse markers (e.g., *uh, well, okay, so*), and intensifiers and deintensifiers (e.g., *kind of, sort of, maybe*). It is through these resources that people indicate levels of certainty about knowledge claims. Because science texts require making authoritative (i.e., certain as opposed to uncertain) claims about information, it is relevant to investigate the role that stance taking serves for students constructing local scientist identities. The four characteristics of science discourse listed in this section represent linguistic resources that I looked for in my analysis of peer interaction and the development of identities of expertise in one ninth-grade science class.

2.4 Inquiry Instruction and Language Learning in Science Education

The push for inquiry-based science education began in the late 1990s with the publication of the new National Science Education Standards in 1996, and *Science for All Children* by the National Academy of Sciences in 1997. These publications charted a course towards reform science teaching and inquiry education as the means to fostering critical scientific thinking in students. The introduction to the new standards (National Academy of Sciences, 1996) contains the following statement about the role of inquiry in reform-based science teaching:

> The *Standards* call for more than "science as process," in which students learn such skills as observing, inferring, and experimenting. Inquiry is central to science learning. When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills. (p. 2)

The report continues by explaining that individual teachers are free to conduct inquiry instruction using approaches that they see fit, that there is no monolithic process for doing inquiry.

Despite variation in how teachers implement inquiry instruction, generally inquiry tasks involve the use of hands-on activities, manipulatives, and cooperative learning. For these reasons, inquiry-based instruction has been identified as an effective approach to science teaching for all students, including ELLs (Lee, 2003). Rosebery, Warren and Conant (1992) found that the use of inquiry-based science lessons led ELLs to begin to appropriate scientific discourse. The study specifically asked to what extent students appropriated scientific ways of knowing and reasoning as a result of their participation in collaborative scientific inquiry (Rosebery, Warren & Conant, 1992). The authors evaluated students' responses to problem solving scenarios in September prior to inquiry instruction and in June after students had participated in multiple inquiry projects. Students' responses were evaluated for specific content knowledge, the number of hypotheses they developed as possible explanations for the phenomena in the scenarios, and the number of experiments students described that would allow scientists to test the suggested hypotheses. The authors analyzed linguistic data to evaluate students' performances (e.g., use of modals in hypotheses, and use of specified or unspecified agents). Rosebery et al. (1992) claim that students showed increases in content knowledge and appropriate use of conditionals in constructing hypotheses over the course of the year. According to the authors, this suggests that students were moving from personal-knowledge-based explanations of scientific phenomena towards an understanding of the role of experimentation in scientific inquiry.

Despite the successes reported by Rosebery et al. (1992), applying inquiry-based science instruction in sheltered science classes has met some challenges. Settlage, Madsen and Rustad (2005) report difficulty in combining an inquiry approach to science teaching with the Sheltered Instruction Observation Protocol (SIOP) teaching model (Echevarria, Vogt, & Short, 2013). The teacher who was the subject of this case study also reported difficulty in assessing content knowledge due to conflating issues with students' language abilities (Settlage et al., 2005). In her response to Settlage et al. (2005), Echevarría (2005) contends that the struggles faced by this teacher are not the result of incompatibility between SIOP teaching and inquiry, but rather that the teacher was not correctly applying the SIOP model. This case study indicates that teachers need specialized training in order to meet the instructional needs of language learners in science classes.

Lee, Buxton, Lewis, and LeRoy (2006) present the results of a professional development intervention aimed at preparing teachers to use inquiry methods with ELLs. Lee (2003) suggests that the process of inquiry can be particularly difficult for ELLs whose home cultures do not construct meaning in ways that are similar to Western science. Lee (2003) further claims that students may struggle with science or resist learning science because of this. Lee et al. (2006) claim that science teachers must recognize this identity struggle experienced by students and work to scaffold inquiry activities through transitioning from a teacher-explicit guided inquiry to student-initiated inquiry. Lee et al. (2006) also argue that attending to students' linguistic and cultural identities while they engage in inquiry leads to greater depth of understanding of science concepts and academic language skills.

In order to scaffold this process Lee et al. (2006) developed an inquiry framework that can be used for any inquiry lesson and contains five stages: questioning, planning, implementing, concluding, and reporting. Though Lee et al. (2006) found some gains in students' content knowledge as a result of the teachers' use of this framework, the researchers did not adequately measure students' linguistic progress. Part of the reason why Lee et al. (2006) struggled to assess students' language gains is due to the fact that their framework does not adequately address the functional language of inquiry or the social roles that students take up when they engage in the practice of inquiry. Thus, while research on inquiry with ELLs exists in the science education literature, the research that has been conducted in this area does not adequately address the linguistic and social demands and processes that coexist in the inquiry process.

I have chosen to limit this study to addressing student identity development and learning during science inquiry tasks because inquiry activities require peer interaction. As I have demonstrated throughout this chapter, peer interaction is understudied in K-12 classrooms despite the likely impact that it has on disciplinary identity development.

CHAPTER 3

METHODOLOGY

Language socialization (LS) research draws from a variety of fields in search of methods and theoretical frameworks to help elucidate how novices learn to speak, practice, and identify as experts. This case study combines methods from ethnography and discourse analysis in order to explore how students develop or do not develop the linguistic and cultural competence to become identified as successful science inquiry students by their peers. The chapter begins with a statement of the ontological (i.e., the nature of reality) and epistemological (i.e., what is knowable about the world) assumptions that frame the research (3.1). Section 3.2 motivates my use of ethnography. Section 3.3 justifies my approach to discourse analysis. Section 3.4 describes the context for the study, and Section 3.5 discusses my positionality and the nature of the relationships I developed with participants. Section 3.6 outlines my data sources and data collection methods. Section 3.7 describes my approach to data analysis.

3.1 Ontology and Epistemology

Bruno Latour (1999) begins his book, *Pandora's Hope: Essays in the Reality of Science Studies*, with a vignette detailing a conversation that he had with a scientist while attending a conference for scientists and researchers in the field of science studies. Latour

(1999) recounts his surprise at being asked apprehensively by a scientist, “Do you believe in reality?” (p. 1). To Latour (1999) this question reflected the scientist’s fear that his aim in writing and philosophizing about science was to devalue scientific ways of knowing. Latour (1999) describes his shock in learning that the scientist felt threatened by his research. He had thought that he was, “in it together” with scientists. I retell this story now in order to remind readers unfamiliar with qualitative research that my goal in conducting this research project is to promote students’ engagement with the sciences, not to establish the superiority of qualitative research over quantitative scientific research. With this in mind, I turn now to a description of the ontological and epistemological orientations behind various research paradigms.

Researchers in the social, behavioral and cognitive sciences employ a variety of research paradigms in their work. For example, psycholinguistic researchers completing experimental studies working under the positivist paradigm assume that one reality exists (ontology) and that the “knower is distinct from the known” (Hatch 2002, p. 13). The goal of most positivist research is to make predictions (Glesne, 2011). Glesne (2011) identifies three additional research paradigms: interpretivism (including constructivism and phenomenological research), critical theory, and poststructuralism. Interpretivist research, such as work completed within constructivism, assumes that multiple realities exist and that these realities are co-constructed by the researcher and the participants (Hatch, 2002). Glesne (2011) cites understanding (as opposed to prediction) as the goal of interpretivist research, and she labels ethnography as an interpretivist methodology. However, Ethnography has a long and storied past stemming from its development in the field of anthropology and subsequent use in other fields.

Although early ethnographic work was conducted under positivist or postpositivist (i.e., reality exists but can never fully be comprehended) assumptions (e.g., Evans-Pritchard, 1937), education researchers today use ethnography in conjunction with other frameworks, including constructivist (e.g., Carlone et al. 2011), critical (e.g., Calabrese Barton, 2001) and poststructuralist (e.g., Duff, 2002) approaches. Thus, an ethnography could be conducted using postpositivist assumptions in which reality can be studied, captured, and understood. In these frameworks, the researcher is distinct from what is being researched. Or, under a constructivist approach, multiple realities are thought to exist and the researcher is inseparable from what is being researched. Glesne (2011) maintains that ethnography conducted under an interpretivist framework assumes that, "reality is socially constructed, complex, and ever changing" (p.8), and that ethnographers seek to understand or "access others' interpretations of some social phenomenon" (p. 8). Though interpretive research can document patterns, the goal of doing so is not to make global predictions but rather to show how participants understand and interact with others in their social worlds (Glesne, 2011).

Rymes (2001) provides an example of an interpretivist approach to microethnography in which she studies language use as a means of revealing what is important to speakers in their local context (in this case, students in an alternative charter high school). Rymes (2001) invokes the notion of coauthorship to explain how discourses are constructed. She claims that, "because speakers are always designing their utterances according to their interlocutors' reactions, the audience becomes 'coauthor' of the speech of any individual" (p. 14). In addition to working from a constructivist position that views discourses as co-constructed by participants, I also acknowledge that in collecting data, I too am a co-author of these data. My selection of when and what to record, how to record, and the camera angles I selected were part of the data collection process, as were my choices during transcription. For this reason, I refer to data collection also as data construction. Just as participants negotiate power in their interactions, I recognize that my position as researcher afforded me positions of power and powerlessness at different moments over the course of this study.

Chapter 2 (Section 2.1) described power as integral to learning and social identification. Because of this, no use or instance of language is neutral or autonomous (Bloome, Carter, Christian, Otto, & Shuart-Faris, 2005). Critical research frameworks claim that knowledge is subjective and political (Hatch, 2002), and that race, class, gender and language affect one's understanding of the world. This study is both interpretivist (Glesne, 2011) and critical, taking the stance that the patterns of language use that are constructed by participants draw from multiple timescales and also have local meanings and consequences. My definition of *critical* differs from approaches that involve participants in the study design (e.g., critical ethnography, Calabrese Barton, 2001). Although most critical studies work towards transforming social structures that systematically marginalize people, critical studies are not necessarily transformative for participants (e.g., Alemán, 2006 and 2009). This study is critical because it seeks to identify barriers to equitable participation in science for one group of language learners even though the participants themselves were not involved in the study design.

Before moving to a discussion of the setting and research methods employed in this study, I address two common criticisms of qualitative research: lack of generalizability and lack of objectivity. I address these criticisms in order to clarify the value of the ontological and epistemological positions of this study. The criticisms stem from attempts to apply positivist notions of reality (that there is one reality and that it can be described) to research conducted using other frameworks that view realities as multiple and never fully describable.

One criticism of qualitative research rests on the claim that the results of such work are not generalizable (Duff, 2008). However, this criticism fails to recognize the strengths of qualitative case study and ethnographic research. Ethnographic research can reveal the social and linguistic processes that explain variation within groups. Let us imagine a quasi-experimental study aimed at determining the effectiveness of a particular type of instruction. In this scenario a researcher seeks to compare two groups of students with respect to their performance on a particular assessment as a result of two different instructional treatments. The experiences of individuals become reduced to numbers that represent their performance on a task, presumably as a result of some treatment (in this case, type of instruction). If the performances of the students in the two, treatment groups result in a statistically significant difference in mean scores on the assessment, the researcher may conclude that a particular type of instruction was effective in promoting the intended results. Crucially, the assumption is that this type of instruction would yield similar results for the population of subjects who participated in the study (e.g., college freshman in their first semester of foreign language study). In this case generalizability to other contexts is the goal of the research project.

If we imagine that an administrator in a university language program reads the results of this study and adopts a policy that requires language instructors to use the type of instruction described in this study, the stakeholders in this context are likely to develop questions that cannot be answered by using a purely positivist orientation. For example, why do some of our students struggle with this instructional practice more than others? How are different teachers implementing this type of instruction in their classrooms and what are the local consequences of these differences? How does this type of instruction impact learners' development of identities as speakers of the target language? In this scenario, the tools to address these questions in ways that are meaningful for these stakeholders would come from qualitative research. The resulting descriptions of local phenomena would be useful to people in other settings who were also using this type of instruction. In this way, case studies seek to provide in depth explanations of what is true for some, not what is true of the many (Merriam, 1998, as cited in Duff, 2008).

Critics of qualitative research also misunderstand the importance of subjectivity. According to Stake (1995, as cited in Duff, 2008), "subjectivity is not seen as a failing needing to be eliminated but as an essential element of understanding" (p. 56). The notion of participant-observation is built on the recognition that researchers must become partial subjects of the community that they are studying in order to access emic knowledge. What does it mean to be objective when one works from the premise that there are multiple realities that can never be fully understood? What is gained from embracing subjectivity?

Heath (1983) used ethnography as an instructional method with a science teacher and a set of young learners who had historically earned low scores on district science assessments. Heath (1983) helped the students and teacher to engage in their own ethnographic study of the local farming community, which led them to produce a hybrid text that discussed the farming history and local knowledge of science in the community alongside descriptions of biological phenomena in scientific terms. On a subsequent science assessment all of the students who participated in the project scored at or above grade level. The ethnographic research that led Heath (1983) to engage in this project was subjective, as was the student research. Heath and Street (2008) caution novice ethnographers to avoid “why” questions and instead favor “what is happening” questions. Heath and Street (2008) remind novices that, “the goals of the social sciences, including anthropology, do not conform to the interests of forgone conclusions based in faith and value judgments about what is true, wonderful, or good, or what is false, ugly, or evil” (p. 35). Though ethnographers are data collection instruments, their role is not to actively attach values to the actions of the participants whom they study.

In the following section of this dissertation I detail some of the methods that ethnographers use to safeguard the production of their data so that they represent the perspectives of participants in addition to the perspectives of the researcher and so that researchers’ biases are made explicit. Finally, it is important to note that objectivity is a socially and linguistically constructed stance (as discussed previously in Section 2.3.2). It is important to remember that these are cultural products as opposed to universal truths. All research is subjective because, “using personal judgment in making research decisions, framing studies based on earlier research, and drawing interpretations and conclusions are involved in all research” (Duff, 2008, p. 55).

3.2 Ethnography – Methodological Overview

Researchers across the many subfields of the social sciences that use ethnography, define it in different ways. Ethnography of communication (EofC) (Saville-Troike, 1982), critical ethnography, internet ethnography, and public ethnography (Marshall & Rossman, 2011) represent more recent versions of this practice that challenge the historical notion of the "innocent ethnographer who enters the field with a mind clear of all presuppositions ready to take part as a full member" (Heath & Street, 2008, p. 34). Saville-Troike (1982) argues that the following question defines EofC: "What does a speaker need to know to communicate appropriately within a particular speech community, and how does he or she learn?" (p. 2). This focus on the cultural knowledge of a community distinguishes ethnography from other qualitative case study research. Duff (2008) claims the following:

> One main difference between *case study* and *ethnography* is that, whereas the former focuses on the behaviors or attributes of individual learners or other individuals/entities, the latter aims to understand and interpret the behaviors, values, and structures of collectivities or social groups with particular reference to the *cultural* basis of those behaviors and values (Duff, 1995, 2002b; Johnson, 1992; Nunan, 1992). (p. 34)

Despite the appeal of this distinction, Duff (2008) continues her description of the two approaches by identifying some of the "case studies within a particular culturally oriented larger case study" (p. 34) in her own language socialization work (Duff, 1995). Duff (2008) recounts her focus on multiple units of analysis: the country, three schools, individual teachers and students, and two types of speech events—all within one EofC (Duff, 1995). At its core ethnography differs from other types of qualitative research through researchers' consistent focus on describing and theorizing about cultural phenomena.

Ethnographers traditionally explore culture via a data collection process known as *participant observation* in which the researcher is both a participant and an observer in the community under study. Researchers' levels of participation and observation vary depending on the research questions and the limitations of the researcher (Glesne, 2011). Because of my age and my racial and linguistic background I was an outsider to students in the current study. I participated minimally in the classroom setting during inquiry tasks. In addition to engaging in participant observation in this ethnography, I use methods of discourse analysis to analyze language use.

The combination of discourse analysis and ethnography I use in this study is sometimes labeled as microethnography (Bloome et al., 2005; Rymes, 2001). Hatch (2002) defines microethnography as "a particular kind of qualitative research usually undertaken by sociolinguists or others interested in verbal and nonverbal communication" (p. 21). Bloome et al. (2005) describe cultural practices, social identities, and power relations as potential areas of study through microethnography. Rymes (2001) labeled her book, *Conversational Borderlands: Language and Identity in an Alternative Urban High School,* a microethnography. She describes her research approach below:

> My research is grounded in a methodology, both anthropological and linguistic, and profoundly empirical, which uses language as a means to explore culture and change (cf., Duranti, 1994; Ochs, 1988; Scheiffelin, 1990). Microanalysis of language practices provides the researcher an empirical *entre* into the complex reality of communities. In this study, language, as viewed through videotaped and audiotaped interactions, provides a means to see the manner in which identities are formed and changed (and certainly masked) within everyday activities at City School. (p. 14)

This description of microethnography centralizes the role of language and the analysis of language in understanding student identities and school culture. Other researchers similarly describe microethnography as a research approach that takes language use as the object of study (Mehan, 1998; Philips, 1993). My approach combines Rymes's (2001) notion of microethnography with a critical identity-based approach to analyzing classroom discourse (Rymes, 2009; Wortham 2005, 2006; Wortham & Reyes, 2015). As a result, I focus on community level communicative norms and practices (Chapter 4) and on the practices and linguistic behaviors of three focal participants (Chapter 5).

3.3 Discourse Analysis – Methodological Overview

Rymes (2008) distinguishes between two categories (ethnographic and semiotic) and three types of LS research (language socialization in education settings, ethnographically focused linguistic anthropology in educational settings, and semiotically focused linguistic anthropology in educational settings). According to Rymes (2008), ethnographic research in the Hymsian tradition does not "have a systematically articulated or unified set of methods for studying signs and linguistic form" (p. 31). While ethnographic research focuses on documenting communicative practices and speech events a semiotic approach "centers on how sign systems, including grammar, classify human experience as culturally relevant and how such forms are deployed flexibly in interaction to create new forms of culturally relevant action" (p. 31). Rymes (2008) addresses the combination of semiotically informed discourse analytic methods embedded in ethnography with the following statement:

> This foundational concern for investigating both normative features of language use and their creative deployment, while rooted in the semiotic tradition, has also permeated later LS work…and this is a point of connection that has fruitfully been carried forward into recent research on LS in educational setting (e.g., Wortham, 2005). (p. 32)

The current study works in this semiotic and ethnographic tradition and extends its use to a classroom setting with L2 English speakers. In this study I explore normative practices (cultural and linguistic) for scientific inquiry in one classroom community, and I describe how three focal participants use linguistic resources to signify their alignment with various local identity models.

Bucholtz and Hall (2004) identify four semiotic processes that are employed by individuals and collectivities in order to construct and signify social identities: *indexicaility, practice*, *ideology*, and *performance*. These processes represent the *how* in identity construction and although they are interrelated, this research centralizes students' use of indexicality and practice.

3.3.1 Indexicality

Indexicality is "the semiotic operation of juxtaposition, whereby one entity or event points to another" (Bucholtz & Hall, 2004, p. 378). Silverstein (1976) developed a theory of indexicality in order to account for the nonreferential meanings conveyed in all languages. Silverstein (1976) draws on C.S. Peirce's notion of icons, indexes, and symbols (the trichotomy of signs). Silverstein (1976) claims "*nonreferential indexes*, or pure indexes, are features of speech which, independent of any referential speech events that may be occurring, signal some particular value of one or more contextual variables" (p. 29). Silverstein continues with, "such indexes as do not contribute to the referential speech event signal the structure of the speech context" (p. 30).

Silverstein (1976) develops his theory of indexicality by providing examples of gender indexes in Koasati (a Muskogean language in the southeastern U.S.), deference indexes in Javanese, and pronouns in English. Silverstein (1976) also notes that "there is a general *creative* or *performative* aspect to the use of pure indexical tokens of certain kinds, which can be said not so much to change the context, as to make explicit and overt the parameters of structure of the ongoing events" (p. 34). Thus, a person's use of particular linguistic features (i.e., indexicals) during interaction signal to his interlocutor the frame of reference or context, and the corresponding social roles or identities, that speakers perceive themselves to be engaged in constructing.

3.3.2 Practice

Bucholtz and Hall (2004) explain that, "through sheer repetition, language, along with other social practices, shapes the social actor's way of being in the world, what Bourdieu calls habitus" (p.377). Although this dissertation primarily examines students' indexical work during physics lab tasks, the goal of this dissertation is to understand students' socialization pathways. Although the pathways under investigation here temporally end at the end of the school year, elements of these pathways are intertextually linked to students' overall trajectories of affiliation or disaffiliation with science disciplines. Thus, when we consider the significance of students' trajectories of participation and social identification in one science class, we hypothesize that their practices on this timescale (one school year) will contribute to each student's overall ways of being (what Bourdieu terms *habitus*). When we consider the language socialization of L2 learners as an act of appropriating a new identity, we see that we hold for these learners the expectation that they will appropriate linguistic features and communicative practices of the expert to index their newly evolving expert habitus.

3.3.3 Identifying Linguistic Practices

Students draw on a vast array of resources to construct local science classroom identities. Bucholtz, Barnwell, Skapoulli and Lee (2012) found that two female undergraduate students in a chemistry lab positioned the third group member as not a science person in part through their reference to this group member as Bill Nye the Science Guy. Bucholtz et al. (2012) demonstrate the unpredictability of the linguistic resources that participants employ to create social roles in the context of a chemistry lab. In my own data, a conversation about hair ended up serving as a proxy for racial and linguistic categories. Students drew on these categories to draw social boundaries when working in a physics lab (see Chapter 5). Eckert (2008) extends this notion of unpredictability into the domain of variationist sociolinguistics, and she argues that, "the meanings of variables are not precise or fixed but rather constitute a field of potential meanings – an indexical field, or constellation of ideologically related meanings, any one of which can be activated in the situated use of the variable" (p. 453). Although I entered the field presuming that lexical items related to science and various stance-taking behaviors would play a role in the construction of local identities, I could not have predicted the identities themselves or the sets of communicative resources that came to index these local identities. As a result of the inability to (concretely) identify particular linguistic features for analysis before entering the field, discourse analysts rely on various systematic approaches to identify relevant linguistic practices in context.

Hanrahan (2006) and Brown et al. (2005) provide readers with matrices that show how they approached analyzing their discourse data. Gee (2011) provides novices with seven groups of guiding questions (based on the seven building tasks of discourses) to answer when analyzing discourse. However Gee (2011) reminds readers that, "real analyses, differently in different cases, concentrate more on some of the building tasks we have discussed than on others; they use some tools of inquiry more thoroughly than they do others" (p. 149). Gee (2011) maintains that no one study can analyze all relevant aspects of discourse. In her book, *Classroom Discourse Analysis*, Rymes (2009) describes four types of linguistic resources (turn-taking, contextualization, genre, and framing) that can be used across three dimensions of discourse (social context, interactional context, and individual agency). Despite providing the most developed account of students' socialization trajectories to date and authoring the very concept of socialization trajectories, Wortham (2006) did not provide a detailed explanation of his methods of data analysis. As a result, I began my initial analysis of discourse using a data analysis matrix I developed from Rymes (2009), which was informed by the trajectory-based approaches of Wortham (2006) and Bucholtz et al. (2012). However, the publication of, *Discourse Analysis Beyond the Speech Event* (Wortham & Reyes, 2015) provided a newly described and more useful approach to analyzing discourse both within and across speech events in my data.

3.3.4 Discourse Analysis Beyond the Speech Event

Wortham and Reyes (2015) outline an approach to within and across event discourse analysis. Both processes (within and across) are reflexive and require revisiting previous steps throughout the analysis procedure. Within event discourse analysis proceeds with mapping narrated and narrating events (relating who is present and participating in the conversation to what is actually being said and by whom), selecting indexicals and identifying relevant context, configuring indexicals, construing indexicals, and identifying positioning and social action in the narrating event. When applied to across event discourse analysis, this approach consists of selecting linked events and mapping narrated events, selecting indexicals and identifying relevant cross-event contexts, delineating cross-event configurations of indexicals, construing indexicals and tracing the shape of a pathway, and identifying emerging cross event actions and processes (see Table 1.2 in Wortham & Reyes, 2015. pp. 22-23). This process explains how Wortham (2006) traced the socialization trajectories (i.e., pathways) of Tyisha and Maurice as they became outcasts and as Maurice subsequently constructed an "in the middle" position (not an outcast, not a promising student). This approach to discourse analysis served as a model for my analysis.

3.4 Context, Access, Participants and Reciprocity

The following subsections justify my choice of school, teacher, and participants. I also describe the types of relationships and responsibilities that I entered into with participants while conducting this study during the 2014-2015 academic year (September through May). The context for the study, one ninth-grade physics classroom, remained small so that a large amount of data could be collected in this setting that lead to "thick description" (Geertz, 1973).

3.4.1 The School

Science For All Academy[8] (SFAA) is located in a mid-sized Western city in the United States. This small district-run charter school has a science focus and aims to enroll students who represent the diversity of children (e.g., economic, racial, and linguistic) who live throughout the school district. There are no entrance requirements for students

[8] The name of the school, as well as all personal names in this dissertation, are pseudonyms with the exception of my own name when it appears in transcripts.

to enroll in the school (e.g., exam scores, etc.); it operates on a lottery system. In informal conversation with teachers who also held administrative roles at the school, I learned that the administration heavily recruits students from the local neighborhood, which contains a large number of Latino/a students, and that they do not recruit as heavily in other areas of the district. According to their website, in fall 2014, the school housed 402 students in Grades 6-12. Forty-nine percent of the students were female, and 51% were male. English Language Learners (as determined by testing at the school) made up 8% of the student body and 50% of students qualified for free or reduced lunch (this conferred the school Title 1 status). In terms of racial diversity, the school reported that the students were 47% White, 37% Hispanic, 6% Pacific islander, 5% African American, 3% multiracial, and 1% Asian. As a result of the school's focus on science and diversity, I refer to the school with the pseudonym, Science for All Academy (SFAA).

The school's ESL specialist claimed that most of the students that enrolled at the school entered at intermediate or advanced levels of English language proficiency. All ELLs enrolled in mainstream science classes. I chose to conduct this research at SFAA because the school aims to promote equity in science education and to help students build the academic skills that they need in order to become scientists in the future. Multiple administrators specifically mentioned a social justice mission as integral to the philosophy at the school during casual conversations. The fact that the school is located within a region of the city with ELLs also ensured that there would be appropriate participants for this study during the 2014-2015 academic year.

3.4.2 The Teacher

Starting in September 2013 I served as a volunteer in the eighth-grade science classroom at SFAA. Although I originally planned to conduct this research with the eighth-grade teacher, she subsequently left the school only a few weeks before the beginning of the 2014-2015 school year. As a result, the former eighth-grade teacher helped to connect me with the ninth-grade physics teacher at the school. After visiting his class during the first few weeks of the school year, I approached him about conducting the study in his classroom and he agreed to participate. While the teacher expressed interest in the study his busy schedule did not permit him to participate collaboratively in data analysis.

Mr. Henderson (henceforth, Mr. H) is a White male native-English speaker who is native to the Western state in which the study was conducted. He completed his teacher education (i.e., a BS and an MS) in physics education at a local state university, and he held the state's endorsements for teaching physics, chemistry, middle school science, and English as a Second Language (ESL). Mr. H started his 13th year of teaching science in fall 2014, and he had been a teacher at the school since the school opened. While he started at SFAA as a middle school teacher, he had been the only physics teacher at the school for 6 years at the time of this study.

3.4.3 The Students

After the consent process 22 out of the 24 students who attended one period of physics agreed to participate in the study and completed the necessary consent paperwork. In this dissertation, I focus on the classroom experiences of a subset of this population. Table 3.1[9] summarizes information about the students who consented to participate in the study and whose experiences are in some way described in this study (a total of 12 students).

While I had originally planned to focus my analysis here on the two students who were labeled English Language Learners by the school, Manuel[10] and OneDirectioner, I was unable to collect sufficient data on Manuel because he changed class periods in January 2015. As a result, I refocused my attention on the experiences of the three bilingual Latina students in this class, Rose, Gu Jun Pyo, and OneDirectioner. Focusing on the socialization of these three students provided a window into commonalities and differences in the ways that students who are often described under the same demographic labels (in this case, Spanish-speaking Latinas) experience in navigating the culture and linguistic expectations of a science classroom.

For this dissertation it is important to keep in mind the lab groups that students participated in during the labs that make up the corpus for this study. During Lab 1, there were two relevant groups. Group 1 contained Manuel, Rico, Alexander, and Gu Jun Pyo; group 2 contained Satan, Potato, Rose and OneDirectioner. For Lab 2 group 1 contained Rico, Manuel, and Gu Jun Pyo; group 2 contained OneDirectioner, Rose, and Potato. Lastly, Lab 3 contained one group with Captain America, Gu Jun Pyo, Rose, and OneDirectioner. Table 3.2 summarizes lab group information. Mr. H created the lab groups for Labs 1 and 2, students had some choice in their partners for Lab 3.

---

[9] All tables and figures are provided at the end of the chapter.
[10] Students selected their own pseudonyms unless otherwise indicated in Table 3.1.

3.4.4 The Lessons

This section describes the instructional context and content goals of each of the three labs that were analyzed for this dissertation. Interpreting the findings in Chapters 4 and 5 requires an understanding of the context for each lab. Although I use the terms lab and inquiry project interchangeably in this dissertation, it is important to note that the inquiry projects described here are all known answer inquiry projects. As in, the teacher provided students with a question to answer and the materials to design an experiment to answer the question. Mr. H varied the amount and type of feedback he provided to students during different phases of the lab based on a variety of factors. Thus, these labs do not represent authentic scientific inquiry projects because the students often knew the relationships they were supposed to be modeling.[11] The teacher often stated in class that part of the goal of these projects was for students to hone their experimental design skills and account for confounding variables as opposed to making original scientific discoveries. Students were required to write their own hypotheses for all lab investigations and with the exception of Lab 1 students wrote and submitted lab reports for almost all lab investigations.

3.4.4.1 Lab 1 – Modeling Gravitational Force

In this experiment students used light boxes to model Newton's Law of Gravitation. In this equation, the force of gravitational attraction between two objects (F) is directly proportional to the product of the masses of the objects (m), and inversely proportional to the square of the distance between the objects (d).

[11] I have no way of knowing who actually knew what after teacher-led discussions prior to students' independent work in the labs. My intention here is to point out that Mr. H discussed what students should find in the lab prior to group work.

$$F = G \frac{m_1 m_2}{d^2}$$

Mr. H used light intensity and distance to model the inverse square relationship present in Newton's law. There were three iterations of the experiment. In the first iteration students varied the distance of a light source from a screen and measured the area of the block of light projected onto the screen. In the second iteration of the lab the screen was replaced with a light sensor and students continued using light boxes. In the third iteration of the lab students used light sensors connected to lab computers that read light intensity, but they were allowed to use other materials besides the original light boxes. Some students continued to use the same basic light box with a few modifications, other students, such as Group 1 created an entirely different lab set up (using a tripod to hold the light sensor, and the light from the LCD projector). Rather than writing lab reports for this lab students created posters in their groups and presented these posters to the class. Figures 3.1 and 3.2 provide pictures of the posters from Groups 1 and 2.

3.4.4.2 Lab 2 – Measuring Electrostatic Force

In Lab 2 students modeled Coulomb's Law by measuring the strength of electrostatic force between a charged balloon and a packet of salt that was placed on a scale. Coulomb's law also contains an inverse square relationship where the force of attraction between two charged particles (F) is directly proportional to the product of the charges on the particles (q) and inversely proportional to the distance between the two charges (d).

$$F = k \frac{q_1 q_2}{d^2}$$

Students used their own hair, a wig, or a piece of fake fur to charge a balloon and hold it over the salt packet, which was sitting on a scale. Students measured the change in mass of the salt packet as a function of the distance between the two charged objects. Students converted the masses from the scale to Newton's in order to demonstrate changes in force. Students wrote lab reports for this experiment. Figure 3.3 provides a picture of Group 2's lab setup for reference.

3.4.4.3 Lab 3 – Measuring the Speed of a Wave

During this lab students attempted to accurately measure the speed of a wave traveling through a suspended rope. Students conducted multiple trials and averaged their results for speed (speed = distance/time). Students measured time by placing two accelerometers hooked up to a lab computer to a rope at a fixed distance. Students measured the distance between the accelerometers using meter sticks. The groups calculated the time by striking the rope in front of the accelerometers and selecting the appropriate points on two graphs (one from each accelerometer) that were displayed on the LabQuest (lab computer) screen, and calculating the difference in time between the two points using functions on the LabQuest. Figure 3.4 contains my drawing of the lab setup.

3.5 Positionality, Researcher as Instrument and Relationships with Participants

Heath and Street (2008) summarize ideas about positionality in the following passage:

> We also enter our field site(s) open to learning. As we do so, we keep in mind the many limitations we bring as instrument. Our physical features (such as age, gender, size, and phenotype), as well as our own cultural identities and life experiences, prevent our fully participating as the "other." (p. 34)

This statement acknowledges that the researcher as a subjective instrument will always present a partial portrayal of the research context. Descriptions of the experiences of participants are partial in that they are incomplete, and they are partial in that they represent the biases of the researcher who collects and reports them. In this dissertation I endeavored to be reflective about how my positionality influenced data collection and data analysis. In order to engage in such reflection, I continually questioned the way that my insider and outsider status impacted the lens I brought to the data.

Brayboy and Deyhle (2000), Foley (2000), Chavez (2008) and Sherif (2001) present accounts of the demands involved in negotiating insider and outsider status. As a White former science teacher of urban multilingual students, I achieved some level of insider status with Mr. H and other teachers in the school. However, in my role as ethnographer and participant-observer, I spent more time interacting with the students than with the teacher. My presence in the class as a researcher afforded me the ability to interact with the students in ways that were atypical for the classroom teacher. For example, in my attempts to understand student experiences during small group work, I sometimes participated in (i.e., by coauthoring) off-task conversations and behavior. For the most part, students in the class ignored me or interacted with me politely when I asked them questions. Only two students came to actively seek my attention and help during class.

It was common for me to visit Gu Jun Pyo and OneDirectioner's table or group at their request to clarify information from the teacher's lectures or from whole class discussions. There were also times when I became more involved with helping particular lab groups during lab tasks because it was important to me to be of service to the student participants. I believe it is unethical to watch students struggling to be successful on an assignment for over an hour without intervening to help them if it is clear that they need help in order to complete the task. This being said, I attempted to minimize the extent and duration of my interactions with students during labs so that I might capture the type of social interactions that would be likely to occur without my participation in the classroom community.

My work with Latina students was influenced by the fact that I am a White European American (non-Latina) researcher who is a very unbalanced English-Spanish bilingual (English-dominant). Although I attempted to speak Spanish with the three focal participants at various times, they always spoke to me in English. My lack of local cultural and linguistic proficiency positioned me as an outsider with these students along this domain of racial and linguistic background. Because of this outsider status and my lack of proficiency in Spanish, I verified my translations and interpretations of Spanish discourse from classroom and interview recordings with native Spanish speakers or high-level bilinguals with linguistics and translation training. Despite the lack of overlap in my cultural and linguistic background and the students' backgrounds, my interest in their lives and their struggles during class served to position me as an adult confidant for OneDirectioner and Gu Jun Pyo. I also feel that because we discussed discrimination in the school during interviews, Gu Jun Pyo and OneDirectioner were more comfortable speaking with me because they knew that I cared about their challenges. In addition, because I could answer many of their content-related questions, I believe OneDirectioner and, in particular, Gu Jun Pyo used my presence as an additional resource to support her academic success. Despite the fact that Rose was often present for class-time conversations that I had with OneDirectioner and Gu Jun Pyo, she did not seem interested in interacting with me beyond the ways in which the other students (regular participants) interacted with me.

The interview results described in Chapter 5 for each focal participant reveal these differing positionalities. I collected more data from OneDirectioner and Gu Jun Pyo than I was able to collect from Rose in part because OneDirectioner and Gu Jun Pyo expressed enjoyment in our interview sessions and a desire to conduct multiple interviews. In qualitative research studies, one's relationship with participants depends on the type of study, theoretical framework and the researcher's notions of validity and trustworthiness. Marshall and Rossman (2011) describe the replacement of notions of reliability, validity, objectivity, and generalizability from positivist research with concerns regarding the credibility, dependability, confirmability, and transferability of qualitative research findings. According to Marshall and Rossman (2011) the latter four criteria are achieved via the inclusion of prolonged engagement, member checks, using multiple data sources, and peer (researcher colleague) debriefing. Marshall and Rossman extend these criteria further by citing Cho and Trent's (2006) validity chart that summarizes five different purposes for qualitative research ("truth" seeking, thick description, developmental, personal essay, praxis/social) and corresponding fundamental questions and validity criteria. Given the dual focus on description and critical analysis presented in this study, the validity criteria for both of these approaches apply to this study and they include triangulated descriptive data, accurate knowledge of daily life, member checks, critical reflexivity of self (as researcher), and redefinition of the status quo. In addition, Gee (2011) describes the validity of discourse analyses as depending on convergence, agreement, coverage, and linguistic details. In order to achieve these efficacy criteria, I engaged in prolonged relationships with the teacher and students, I critically reflected on how my values impacted data analysis, I conducted member-checks, and I reviewed segments of data with other researchers.

3.5.1 Ethics and Reciprocity

Marshall and Rossman (2011) claim that the trustworthiness of a qualitative study depends on the level of trust built between the researcher and the participants. I built trust with the teacher by complimenting aspects of his instruction, chatting with him informally about our experiences teaching physics, and offering my services as a chaperone on physics field trips. In terms of reciprocity, I plan to share the results of this research with the teacher so that he can use the information for his own purposes. As mentioned above, for student participants I regularly circulated the classroom when they worked in small groups to provide assistance when needed. I reiterated that students should email me if they ever considered that I might be of service to them in the future. These relatively small acts of reciprocity served to build trust between the participants and me, and they served to ensure that students felt some positive outcome of my presence in the classroom.

It is my sincere hope that students and the teacher also gained self-awareness from participating in the study, that in turn will empower them to participate in the classroom setting in new ways or, at the very least, to develop new perspectives about their participation. Rymes (2009) claims that the act of asking a question can often lead participants to reflect critically and perhaps modify their actions.

3.6 Data Collection

This study used an iterative process of data collection and analysis. As with all ethnographic studies, data were subjected to initial review as they were collected, as well as final analysis prior to reporting. Glesne (2011) depicts a qualitative research spiral in which data collection, data analysis, literature review, additional reading, interpretations, and the formation of new research questions are all interconnected throughout the research process. Imagining the steps that go into navigating Glesne's (2011) diagram conjures Hatch's (2002) notion of flexible structure. Glesne's (2011) diagram served as a frame of reference for this inquiry rather than a step-by-step process for conducting research. Gee (2011) in discussing his approach to critical discourse analysis and Heath and Street (2008) in their discussion of ethnography both highlight the impossibility of using rigid steps to guide research.

In an effort to tease apart the collection and analysis procedures, the subsections below address only data collection procedures while Section 3.7 explains the specific analysis procedures used in this study. I reiterate that these are not temporally distinct phases.

3.6.1 Time on Site

During the 2014-2015 academic year, I collected observational data from September to March with one 2-week break in February, and one 2-week break in March.

I did not collect data in April due to the school district's rules about research during the month when students undergo state testing. After collecting observational data in March, I returned to the school to conduct final interviews in May. During the phases of the year when I collected observational data I attended the 1.5-hour class periods three times per week.

Explicit standards for the acceptable length and duration of visits researchers make to classroom settings in which they participate do not exist. Bucholtz et al. (2012) collected data for one semester, which represented the entire length of the college course under study. Although Wortham (2006) delineates the local timescale of a secondary school setting as 1 year, he demonstrated (Wortham, 2008) that meaningful identity trajectories could be described on smaller timescales. Though Shuman (1986) conducted 3 years of fieldwork in a high school and Rymes (2003) conducted 2 years of fieldwork, 1 school year was appropriate for answering the research questions outlined in Chapter 1. The breaks in collection of observational data allowed me to make progress on processing and reviewing the data that I collected.

Some classroom discourse analysis studies involve limited time in the classroom (e.g., Hanrahan, 2006). However this limits the types of questions that can be asked and answered. Rymes (2003) spent 1 day per week in her research context, Moje et al. (2001) spent 2 days per week on site, and according to Labov's (2002) review of Eckert (2000), Eckert (2000) worked at her field site daily. Street and Heath (2008) reiterate that there is no magic number of days or hours that must be spent in the field in order to conduct quality ethnographic research and that researchers should make such decisions taking into consideration their other life commitments. Based on the rough norms cited here, the 3 days per week that I spent in the classroom were sufficient for me to collect the necessary data to answer my research questions.

3.6.2 Field Notes

Glesne (2011) and Hatch (2002) recommend that researchers locate themselves on the observation-participation continuum before entering the field and that the decision should be based on the researcher's goals. Given my desire to build rapport with students, I participated moderately (Hatch, 2002) throughout the duration of my time in the field. As previously described, I varied my level of participation with different student groups depending on student factors (e.g., students needing help) and based on shifts in my research goals (Hatch, 2002). My field notes reflect this positioning.

In addition to the classroom observations and immediate reflections captured in daily field notes, I also periodically observed students in other locations in the school. I would walk through the building during lunch, I attended a few school events and one field trip. I used the information gleaned from these observations to develop a better understanding of the students' social networks at the school and to learn more about the mission and philosophy of the school as communicated by teachers on field trips and a prospective family night.

3.6.3 Classroom Video and Audio Recordings

No clear standards exist to outline how frequently or how (logistically) classroom video or audio data should be collected for discourse analysis or language socialization projects. Researchers report recording as often as possible which may be once per week

(Rymes & Anderson, 2004), every day (Cole, 2002), or 50 times over the course of the school year (Wortham, 2006). Because I focus on inquiry instruction for this dissertation, I originally planned to record every inquiry lesson in one physics class for the duration of the project. However, because students frequently worked in lab groups, and because the teacher was not always aware of his exact plans for class in advance, I decided to simply attend class for 3 days per week and to video and audio record every day that I attended class. Because some students did not complete the consent process until November, this approach to data collection led me to collect over 200 hours of video and audio recordings from 29 class periods spread over 5 months (November to March). Each class period was divided into Part 1, 45 minutes before lunch, and Part 2, 45 minutes following lunch. Science periods were double blocked at 1.5 hours per day due to the school's science focus. During every lab period I recorded up to six individual lab groups. I used one HD video camera with a wide angle to capture general movements of students. At times, I focused the camera on specific lab groups. I recorded lab groups using small digital recorders, which I placed at lab stations depending on where students were working on any given day. Students had considerable freedom to move around the classroom and the large size of the room allowed students to spread out and work in a variety of locations. I placed recorders in locations where students were working. This sometimes involved moving the recorder and following students to a new location in the room. This constraint of using free recorders as opposed to body microphones led to some loss of data due to student mobility and sound interference from lab activities. However, I felt that using the movable recorders presented the best option given financial and logistical constraints.

I used Adobe Premier Pro software to sync audio and video data. This proved useful for reconstructing conversations and overcoming some of the limitation of using free-standing microphones. Conversations that faded away on one recording could often be picked up on another recording as students moved to different locations in the room.

3.6.3.1 Creation of the Classroom Discourse Corpus

From the 29 class periods that I recorded, I selected three labs to serve as the focal inquiry lessons and to be used for analysis in this dissertation. I selected these labs based on having the most complete recordings of the focal participants for those inquiry projects. Appendix A contains a log of the relevant recordings that make up the corpus. The corpus contains recordings from 25 class parts, which totals 18 hours and 45 minutes. The recordings span 9 different days of instruction.

3.6.4 Teacher Interviews

I conducted two teacher interviews, which are not analyzed in this dissertation. Although this is a language socialization study, I primarily examine peer socialization in the lab context. I do identify structural barriers to equitable participation that could be addressed with instructional interventions (Chapter 6); however, the teacher's perceptions of students' experiences in his classroom are not the subject of inquiry for this dissertation. Future studies from this ethnographic project will undoubtedly include examinations of teacher-led classroom discourse, and the teacher perspectives garnered from the interviews.

3.6.5 Student Interviews

I conducted two rounds of student interviews. In Round 1, I interviewed 17 of the 22 students who agreed to participate in this study using a semistructured interview protocol (see Appendix B). The interviews took place during lunch or after school and they lasted between 30 and 45 minutes. Two of 17 students, Gu Jun Pyo and OneDirectioner, initially asked to be interviewed together. Because we ran out of time to complete the interview in one session, we scheduled a second group interview to ensure that I was able to hear them each respond to all of the interview questions. Because these two participants were eager to talk with me, we also scheduled two additional group interviews over the course of data collection. Thus, in Round 1 I interviewed 15 of the students once each, and two of the focal participants four times in group interviews. The purpose of the first round of interviews was to collect information to help me select focal participants, to establish rapport with all of the participants, and to gather general information about students' backgrounds, experiences in school in general, their experiences with science at home and in school, and the social relationships that were important to them.

The second round of interviews was more abbreviated. I interviewed each of the three focal participants one time in May or June. These final interviews were conducted using Carlone's (2012) *norms and values card sort* activity to facilitate a discussion of normative science classroom practices (used in Carlone et al., 2011). This approach allowed me to member check the hypotheses that I had developed related to characteristics that I perceived to be important for being good physics students in this classroom community. Under this approach the researcher identifies normative practices in a classroom community and writes these practices on index cards. When Carlone et al. (2011) used this strategy with students the cards said things like, “In this science class, we are expected to: TALK LIKE SCIENTISTS” (p. 18). Appendix C lists the items that I placed on cards to test my perceptions of the norms for this physics class. Student participants then completed three tasks with the cards.

First, participants sorted the cards into yes, maybe, and no, categories based on practices they felt that they needed to do regularly in order to be considered a good physics student. I then asked follow up questions such as “What does it mean to [statement on card] in this class?” and “Can you give me an example of a time when you did [statement on card]?” (Carlone 2012, p. 18). In the second task participants selected three cards that represented the most important practices and values for being a good science student. The third task involved selecting the three cards that represented the practices of the participants’ imagined ideal science classroom communities.

3.6.6 Artifacts

During my time in the classroom I periodically collected artifacts, such as copies of students’ lab reports, copies of assignments from the teacher, and pictures of lab set-ups. I asked students for their permission each time that I copied or photographed their work.

3.7 Data Analysis

Heath and Street (2008) discuss the importance of cultivating a *constant comparative perspective* when conducting ethnographic fieldwork and data analysis. A constant comparative approach is inherent in the iterative work of many qualitative researchers. Glesne (2011) provides a diagram of the research process that I found useful while planning this study. However, I followed a slightly different pathway from the one she depicted. Figure 3.5 contains a depiction of my research and data analysis process for the reader to reference while reading the subsequent sections of this chapter. The diagram begins at the top where I initiated this project by reviewing literature and spending time in various science classrooms at SFAA. From these experiences I developed initial research questions. Once I gained IRB approval and consent from the school district, teacher, and students to conduct the study, I began cycles of data collection and initial analysis. Throughout these cycles I sought new literature to inform my analyses and initial interpretations. Once I left the field I revised my research questions and conducted final rounds of data analysis of interviews and classroom discourse data. From these analyses I developed the hypotheses, theories, and conclusions discussed in Chapters 4-6.

3.7.1 Transcribing Classroom Talk

In her proposal for a revised approach to transcribing child speech, Ochs (1979) points out the critical role that transcription plays in supporting qualitative researchers in answering their research questions and in constructing data, particularly in studies that analyze discourse. The decisions made while transcribing shape the data and make possible the type of analysis the researcher seeks to accomplish. Seedhouse (2004), Wortham (2001, 2005, 2006, 2008), Bucholtz et al. (2011, 2012) and the other discourse analysis studies mentioned throughout this dissertation use similar transcription conventions derived from the field of Conversation Analysis (CA) (Atkinson & Heritage, 1984), a particular type of discourse analysis.

Wortham (2001, 2006) does not include gesture in his treatment of classroom discourse while Bucholtz et al. (2011, 2012) do include gesture. Although my analyses centralize language as a semiotic resource and an object of analysis in this dissertation, I included gestural data in my corpus when they were available and relevant to parsing verbal data. The transcription conventions that I modified from Bucholtz et al. (2011, 2012; derived from Du Bois et al., 1992) which include gesture, are found in Appendix D.

In an example of the importance of gesture, Wortham (2008), in contrast to his earlier works that did not include gestures, traced the identity trajectory of one student across lab events in one classroom. He arranged his analysis around a focal event that involved the physical manipulation of lab material, which he calls “the grab.” Essentially Wortham (2008) claims that “the grab” set in motion a local trajectory. Because tool use is integral to students’ completion of lab tasks I included descriptions of students’ manipulations of materials when such information was visible on camera. The limitations of recording with one camera made documentation of all gestures impossible. However, because I recorded in high definition, I was able to zoom in and describe physical gestures in groups that may have been more than 20 feet from the camera.

While Bucholtz et al. (2011, 2012) separated lines in their transcripts according to gestures, eye gaze, and intonation units, I chose to break lines primarily based on turns at talk in order to produce manageable transcripts for my corpus. Even with this decision, a transcription of 1 day of interaction in one lab group easily yielded over 1500 lines of text (approximately 50 pages). However, as indicated in some of the extracts provided as exemplars in Chapters 4 and 5, I re-broke lines at the ends of intonation units during final analysis if a student's intonation became relevant to the analysis.

Just as the overall research process was iterative, so too was my selection of events to transcribe and analyze during this phase of the project. I began my transcriptions of discourse data with Labs 2 and 3 since these labs each occurred over two class periods (as opposed to the longer time frame for Lab 1). Instead of transcribing all of the potentially relevant data in Lab 1, I decided to map the corpus first. This mapping generated 128 pages of hand written time-stamped notes on events that occurred in these recordings as well as analytical notes listed on post-it notes across these pages. I also color-coded my notes based on emerging themes so that it would be possible to relocate important events for further analysis. I then selectively transcribed sections of discourse from Lab 1.

3.7.2 Transcription Conventions for Interview Data

The interviews were transcribed and coded for content. Although applying a discourse analysis lens to the interviews would be interesting, the purpose of the two rounds of interviews was to develop background knowledge about the participants and to member check findings using the "norms and values card sort." The only nonlinguistic features present in the interview transcripts are time stamps and laughter (indicated with @).

3.7.3 Analyzing Classroom Talk

As mentioned above, I applied Wortham and Reyes' (2015) approach to discourses analysis beyond the speech event to the data in my corpus. Under this approach, I selected sections of classroom discourse and I mapped the narrated events in these sections. However, Rymes (2009) points out that conversations can contain intertextual links across large spans of time. For example, in Lab 3, the participants repeatedly revisited a discussion about sports teams at the school. Over time as the girls revisited the topic and rearticulated their stances related to school activities, Captain America and Rose became aligned with each other as the type of students who engage in extracurricular activities (reminiscent of Eckert's 2000 description of "Jocks") while Gu Jun Pyo and OneDirectioner became aligned as outcasts, or students who are critical of school sanctioned activities. This positioning influenced the way that students discussed the science content with parallel alignments drawn along the same lines as the school activities conversation. It is in this way that the narrated and narrating events of the discourse converge to create social positionings. Of relevance here is the fact that the school activities conversation was picked up and dropped three times over the course of the 1.5-hour class period. Mapping these types of intertextual links was the first step of the process for analyzing classroom discourse.

In addition to identifying intertextual links based on conversations unrelated to science content, I also looked for intertextual links in how students discussed science content. As Reyes (2016, personal communication) discusses, it is impossible to trace students' socialization pathways without also understanding the meanings of various practices in the classroom. This mapping of science related conversations and my subsequent analysis of indexicals allowed me to identify three local identity models for success in this physics classroom, and to hypothesize about the practices that signified these models. The findings from this work are described in Chapter 4.

The processes of selecting, configuring, and construing indexicals is iterative. Initially, the researcher selects indexicals that participants may be orienting to in terms of defining the context and social roles of their interaction. For example, I initially looked at instances where students used scientific vocabulary as an index of expertise. I then looked for co-occurring linguistic and behavioral signs. For example, students who used scientific vocabulary during laboratory investigations also tended to interrupt their peers and issue commands to their peers related to setting up the lab and collecting data. In conversation interlocutors attend to some indexical relationships more than others. Thus, researchers may initially select indexicals that do not end up in their final analyses. Wortham and Reyes (2015) describe the process of paring down possible indexicals to locate a mutually reinforcing constellation of signs as configuring indexicals. After this phase researchers examine how these constellations of signs become entextualized. Entextualization is the process by which certain signs come to indicate stable and identifiable types of social action. For example, in this study, as a result of entextualization, the practices of using scientific vocabulary and issuing commands to peers about the manipulation of science objects came to indicate a reliable local social type, the *science expert*. The characteristics of the science expert persona in this physics classroom may overlap with other pop culture or societal notions of the kinds of people who are science experts. However, an examination of these overlaps (intertextual relationships) goes beyond scope of this dissertation. I endeavored to identify the emergent local meanings of the indexical signs I identified. In the final stage of the analysis of a piece of discourse the researcher examines the social positioning that results from participants' uses of various indexical signs.

In addition to analyzing individual conversations with this approach, Wortham and Reyes (2015) demonstrate how to apply a similar approach to identifying intertextual links across multiple conversations. For example, in this dissertation I identified communicative practices that came to index three local identity models for success in the science classroom, the *science expert*, the *good student*, and the *good assistant*. I did this by examining the practices of students across all of the labs in my corpus and by examining my field notes. For example, as already mentioned, I looked at instances of technical or scientific language use across the corpus to determine the co-occurring signs that came to index the science expert identity. I repeated this process for each of the identity models that I describe in this dissertation.

In order to answer Research Question 2 and trace the focal participants' pathways of social identification, I looked at two levels of social identification. First, I examined how the focal participants used the practices indicative of each of the three identity models across the three labs in the corpus. Second, I examined how each student was positioned by nonscience conversations in each lab. The findings from this analysis are presented in Chapter 5.

3.7.4 Analyzing Interview Data

I made use of both inductive and deductive coding for this research project. When conducting inductive coding, also known as open coding, researchers label extracts of conversation based on emergent themes from participants' comments (Bernard, 2006). With deductive coding, researchers apply a predetermined coding scheme to parsing and labeling their data (Bernard, 2006). Both approaches were useful for my analyses at different stages of the research process.

As mentioned earlier, I conducted two rounds of interviews. In the first round I interviewed 17 students to learn about their backgrounds related to science and language learning. In the second round of interviews I conducted the norms and values card sort task with each of the three focal participants. I analyzed interviews in two phases. During the first phase of analysis I conducted inductive coding on the Round 1 interviews to try to get a general sense of what mattered to my participants relevant to science and language learning and to identify initial themes. I then recoded relevant sections of the interviews, once I had also analyzed some discourse data, using deductive coding surrounding issues related to science identities. I used a similar process for the Round 2 interviews, which contained more structured conversation due to the task I asked students to complete. However, I coded students' elaborated responses from these interviews inductively as I wanted to ensure that I drew connections to their initial interviews and interactions in class.

Table 3.1 Characteristics of Student Participants

*Name**	*Gender (M = male F = female)*	*Number of interviews*	*English Language Learner (X = yes)*	*Spanish-English Bilingual (X = yes)*	*Additional racial, ethnic, linguistic or other relevant information***	*Parent occupations*
Rose	F	2	X	X	Mexican American	Custodian & Superstore employee
OneDirectioner	F	5		X	From Dominican Republic	Employee for a church organization
Gu Jun Pyo	F	5		X	From Peru	NA***
Rico	M	1		X	Mexican American	NA
Manuel*	M	1	X	X	From Mexico	Construction
Potato	M	1			White	Gastroenterologist & Optometrist
Captain America	F	1			White	Engineer & Doctor
Satan	F	1			Biracial (African American & White)	Disability & Manager of a chain restaurant
Tinki Winki	F	1			White	NA
Lazarus	M	1			White	NA
Alexander*	M	1			White, Russian-English Bilingual	Engineer
Viktor*	M	1			White	NA

*All names are pseudonyms. Names marked with an asterisk indicate names that I selected in the absence of a student-selected name (Manuel & Viktor) or in the absence of an appropriate pseudonym (Alexander selected "God" as his pseudonym which I deemed inappropriate for this publication).
**Students who are listed as being from a country other than the United States are either not U.S. citizens or their citizenship status was unclear at the time of the study. Alexander was born in the United States but he speaks Russian at home with his family. Unless otherwise stated, all students were monolingual English speakers.
***NA means not available. I hope to collect this missing information in a future study with the same participants.

Table 3.2 Student Lab Groups Across Three Labs

	Group 1	*Group 2*
Lab 1	Manuel, Rico, Alexander, Gu Jun Pyo	Potato, Satan, Rose, OneDirectioner
Lab 2	Rico, Manuel, Gu Jun Pyo	Potato, Rose, OneDirectioner
Lab 3	Captain America, Rose, OneDirectioner, Gu Jun Pyo	

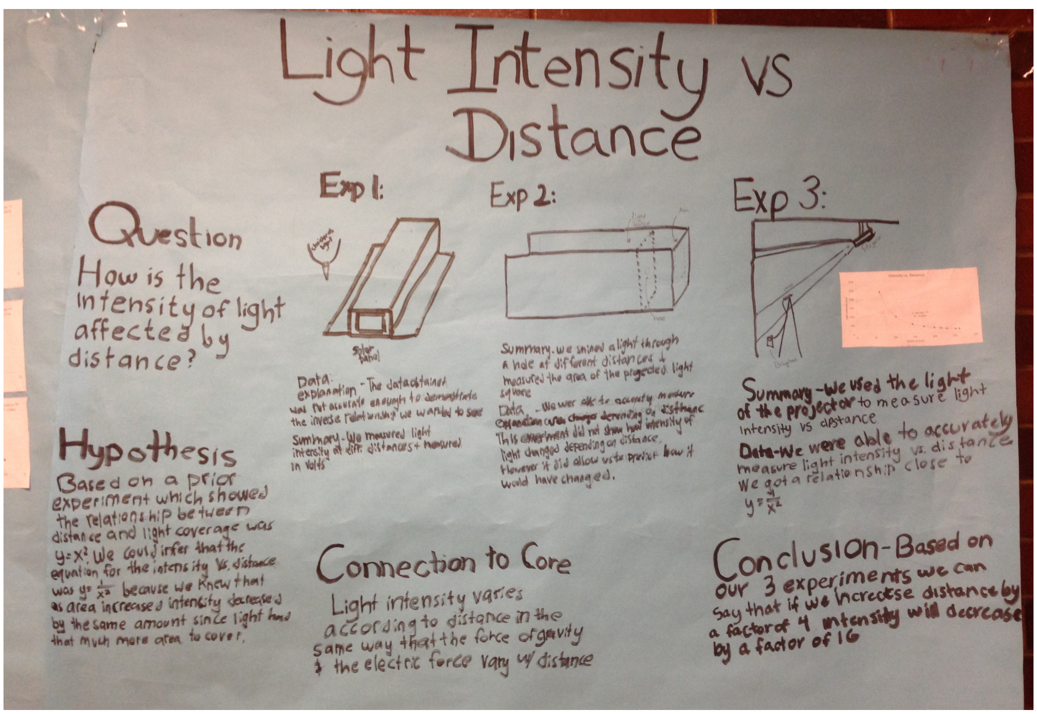

Figure 3.1 Picture of Lab Poster for Group 1, Lab 1

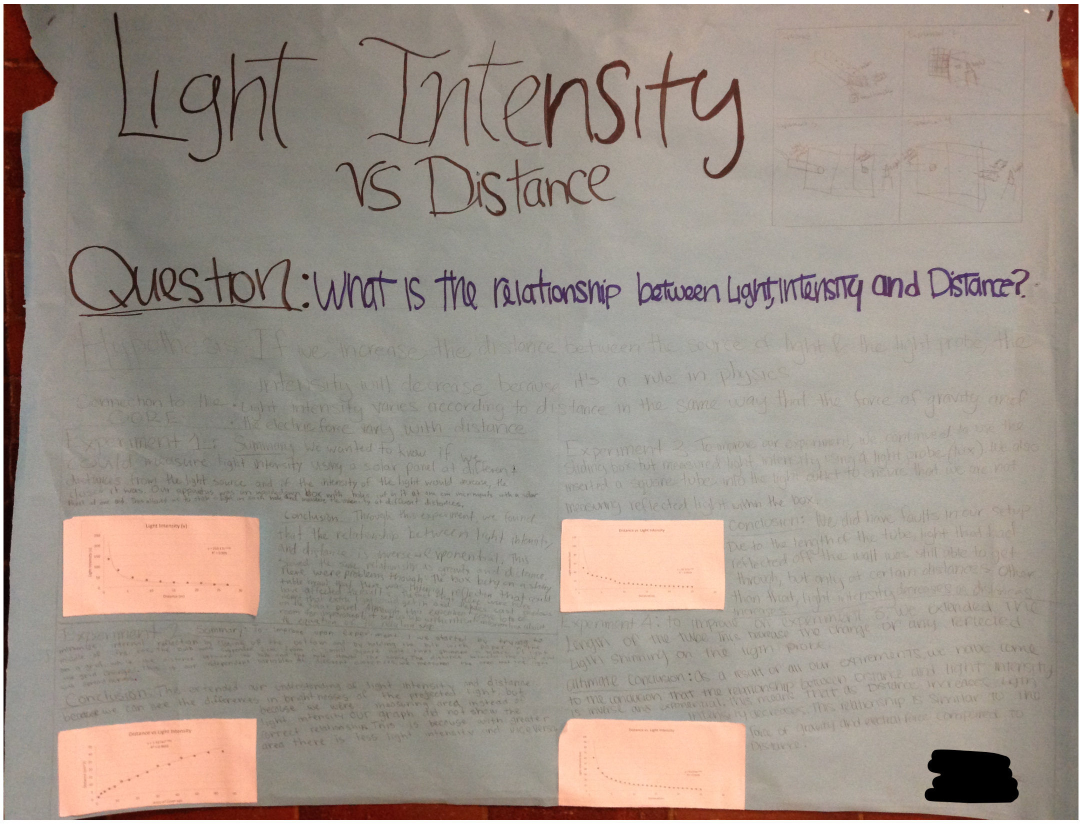

Figure 3.2 Picture of Lab Poster for Group 2, Lab 1

Figure 3.3 Picture of Lab Setup from Group 2, Lab 2

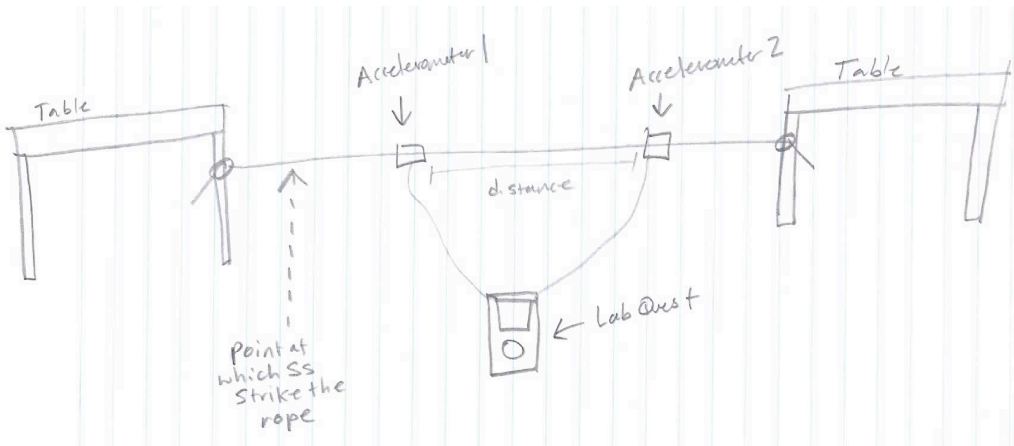

Figure 3.4 Drawing of Lab 3 Setup

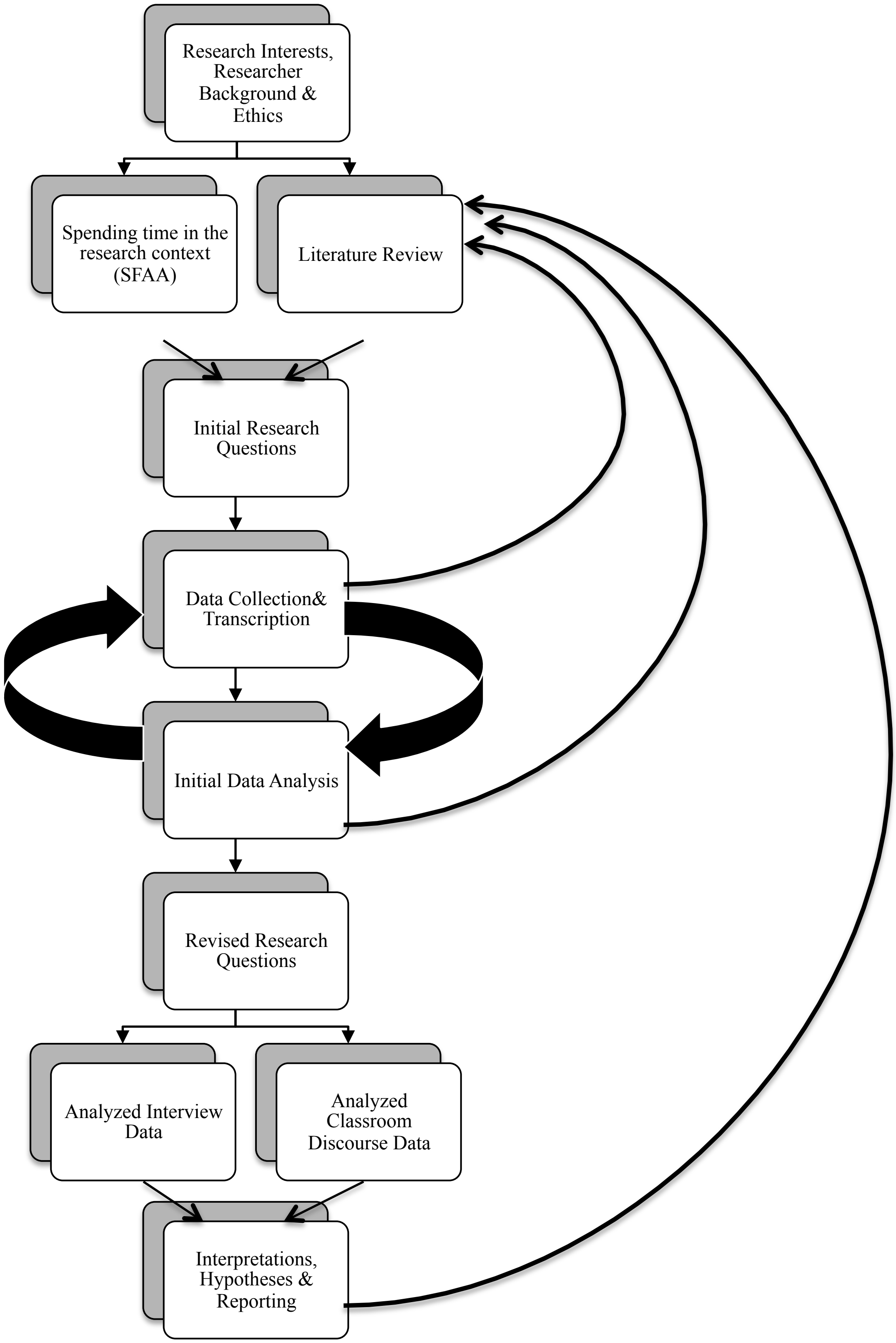

Figure 3.5 Diagram of the Research Process

CHAPTER 4

RESULTS: DISCURSIVELY CONSTRUCTED LOCAL IDENTITY MODELS

This chapter summarizes findings related to Research Question 1: (a) What local identity models are associated with success during inquiry instruction in one ninth-grade physics class? (b) How do students discursively construct these identities? Students discursively constructed three local identities related to successful participation in science inquiry tasks: the *science expert*, the *good student*, and the *good assistant*. Students' negotiations of these positions lead to the formation of local expertise hierarchies, meaning that some students were positioned as the most expert students, and others were positioned as having little relevant science expertise. This chapter begins with an overview of the three identity models in Section 4.1. Sections 4.2, 4.3, and 4.4 provide additional details about each identity model and the role that technical language plays in shaping each model. Section 4.5 provides an illustration of what the three identity models look like in interaction. Finally, Section 4.6 formalizes the notion of local expertise hierarchies in preparation for discussing students' individual language socialization pathways in Chapter 5.

4.1 Overview of Identity Models for Success

In order to understand how individual students become positioned to be successful or unsuccessful science students, we must first understand the community norms for success. In the physics classroom that served as the site for this research project three local identity models led to explicit and implicit positive evaluations related to academic success and success in the sciences. Students in this ninth-grade physics class constructed the following identities: the *science expert*, the *good student*, and the *good assistant*. Students articulated these positions by flexibly employing constellations of communicative signs. By examining student practices across the three labs in my corpus I identified the characteristics of each local identity model depicted in Table 4.1. As described in Chapter 3, I used an iterative process of hypothesis testing to develop the list of practices described in Table 4.1.

Table 4.1 summarizes the communicative practices of *science experts*, *good students*, and *good assistants* across nine domains: technical language, directives and peer nominations, permission, silence, verbal evaluations, materials use, negotiating uncertainty, teacher interactions, and stance-taking. Reading the table vertically provides insight into the assemblage of practices that came to index each individual identity. For example, good assistants used technical language incidentally if at all, they obeyed commands, asked for permission from their peers, were often silent, solicited approval for their work from their peers, manipulated lab materials only under the direction of their peers, did not interact with the teacher, and avoided agreeing or disagreeing verbally with their peers. Taken together, these communicative signs pointed to a student articulating a *good assistant* identity.

Alternatively, reading the table horizontally allows for comparisons between the local identity models across individual types of communicative tasks. For example, while *good assistants* solicited approval for their work from *good students* and *science experts*, good students tended to evaluate peer performances related to task completion, while science experts evaluated the quality of their peers' work with respect to scientific principles like accuracy and consistency. The subsections below further explicate the practices associated with each local identity model and provide examples of how students deployed these communicative resources during inquiry tasks. Although this chapter discusses the archetypal practices and behaviors of each of the three identity models, individual students moved between identities with varying degrees of flexibility and fluidity (see Chapter 5 for examples).

4.2 The Science Expert Identity

The students in this classroom oriented themselves to a perceivable "science expert" identity. Although students did not use the terminology that I suggest here (*good student* and *science expert*) students discussed the characteristics of "science people" in interviews in ways that often pointed to a distinction between those who are interested in science and those who simply care about getting good grades. In addition to the descriptions provided by students in interviews (Section 4.2.1), an analysis of the communicative behaviors exhibited by students during science labs revealed the set of behaviors that are indicative of the *science expert* model and summarized in Table 4.1. As mentioned previously, students used the set of behaviors that are ideologically linked to the science expert persona in flexible ways. For example, while Potato and Captain

America reliably became identified as science experts in my corpus, they used silence and technical language differently. No student embodies all of the characteristics of a model all of the time, but rather, particular behaviors and communicative practices when used together in various combinations by the students in this classroom came to index a science expert persona.

4.2.1 Student Interviews

Students' interview responses related to three interview questions (from the first round of interviews described in Chapter 3) demonstrate how they conceived of the characteristics of "science people." Because the interview protocol (provided in Appendix B and described in Chapter 3) preceded identification of the *science expert*, *good student*, and *good assistant* identity models, the questions do not specifically address differences between these identities. In two instances where students were interviewed later in the project, I was able to ask follow up questions related to the differences between good students and science people. However, for the majority of the interviews the questions focused on what it means to be a "science person" and who students in the class perceived to be science people. The specific interview questions include: 1. Do you consider yourself to be a science person? Why or why not? 2. Who do you consider to be a science person and why? 3. Who would you choose to work with in a lab group and why?

The interviews summarized here come from the nine students who participated in the five lab groups that make up the corpus for this study. Due to time constraints and other factors there are some gaps in the data collected from OneDirectioner, Manuel, and

Rico. These gaps are discussed in context below. From the interviews analyzed three themes emerged as representing characteristics of science people: an interest in science, demonstrated ability in science, and participation in science-related communities. Table 4.2 summarizes student comments related to these themes and lists the number of students who discussed each theme. Table 4.2 reveals that six of the eight students mentioned an interest in science as the defining characteristic of being a science person, two of the eight students mentioned the importance of demonstrating ability in science, and two of the eight students discussed participation in a science community as defining characteristics. These comments emerged when students talked about others and when they talked about themselves as “science people.” Only two students (Gu Jun Pyo and Rose) linked being a science person to characteristics related to being a good student (understanding easily, getting good grades, etc.). Gu Jun Pyo and Rose are also the two students who were somewhat reluctant in labeling themselves as science people despite their interests in science and in pursuing science careers (Rose – surgeon; Gu Jun Pyo – engineer). In addition to associating positive classroom performances with science people, Gu Jun Pyo commented that Viktor “he’s good at understanding but sometimes he tries to like say more and more but that’s where he gets, like where he’s not good.” Gu Jun Pyo seemed to view Viktor as not a science person because of this inability to perform in whole class discussions. However it is possible that other students saw Viktor’s participation in class discussions as a sign of his interest in science. Gu Jun Pyo also mentioned that some students seem like they would be smart because of the cliques that they belong to, but, that when you talk with those students they are “lost as well” (Group Interview 01/29/15). Thus for some students being a science person related more to interest in science and for others (i.e., Gu Jun Pyo) performance of expertise was central.

Of the participants in this subset of interviews four students identified themselves as science people without reservation (Satan, Potato, Alexander, Captain America), two students reluctantly indicated that they might be science people (Gu Jun Pyo, Rose), two students indicated that they did not see themselves as science people (Rico, OneDirectioner), and one student did not address this question (Manuel). In addition to talking about themselves as science people or not, students also discussed who in their class they considered to be science people. Table 4.3 contains a comparison of self-reported “science person” identities and the number of students other than the individual who also indicated that they viewed the person as a science person.

Two of the students who indicated that they viewed themselves as science people (Rose and Satan) were not identified as science people by their peers. Gu Jun Pyo received only one indication of herself as a scientist, which came from Rose. Students also listed three other students whose interviews are not analyzed here as science people (Tinki Winki (3), Viktor (2), Lazarus (1)). Each of the male participants who were identified by peers as science people regularly participated in class discussions. They were often the only students to voluntarily participate in class discussions without being called on by the teacher. It is likely that this active participation in class demonstrated to others these students’ interest in the subject matter and in some cases their knowledge and proficiency in discussing science topics. The girls who were labeled as science people by multiple peers, Captain America and Tinki Winki, both participate in the science fair regularly and the honors program for physics. Neither of these girls spoke often in class unless called on by the teacher. Lastly, Rose identified Gu Jun Pyo as a science person because she “understands stuff easier and she like seems more interested and stuff like that” (Individual Interview, 01/28/15). Rose and Gu Jun Pyo were friends and regularly worked together in class with OneDirectioner and other Latino students. Although Rose was not often placed in a lab group with Gu Jun Pyo, she had extensive experience working with her and she often deferred to Gu Jun Pyo’s expertise in these nonlab group-work settings. Rose’s deference to Gu Jun Pyo is also apparent in Lab 3 from the corpus analyzed here (discussed in more detail in Chapter 5).

How do these interview findings relate to the proposed division of successful student identities and the science expert persona? Students articulated that science people are passionate about learning science and that they willingly engage in conversations about science topics. This perspective overlaps with some of the interactional characteristics of *science experts*.

4.2.2 Communicative Practices of Science Experts

Review of the corpus revealed that multiple cues index the *science expert* identity during interaction. In addition to willing engagement in discussions of scientific content and productions of technical explanations, students also constructed *science expert* identity stances by issuing directives to peers related to lab setups and data collection, interrupting peers, granting permission to others for actions related to the lab, selectively ignoring peer comments, negatively and positively evaluating peer performances related to lab setup and data collection, physically controlling lab materials, directing questions to the teacher, and verbally disagreeing with their peers (summarized in Table 4.1). I discuss the role of technical language in the construction of a science expert persona in more detail in Section 4.2.2.1 because it represents the component of science discourse in which students explicitly negotiate science content knowledge.

4.2.2.1 Technical Language of Science Experts

The technical language accompanying lab work during inquiry projects in this ninth-grade classroom did not contain many scientific lexical items. The activities in which students used the most scientific vocabulary were writing sections of the lab report, planning presentations and presenting their work to the class. The structure of Lab 1 (light intensity) led students to conduct each of these three activities as a group. However, in Labs 2 (electrostatic force) and 3 (wave speed) students finished their lab reports at home and did not present their results to the class in the postlab phase (See Chapter 3 for a reminder of the activity structures in each lab). The physical activities of manipulating materials to set up the lab and collecting data were characterized by personal, spatial, and temporal deixis. However, claiming that "technical language" only includes the scientific vocabulary used during report writing and presentation modes would be shortsighted. Doing science requires the ability to do and speak confidently about the scientific phenomena themselves as well as the processes of setting up a lab, collecting data, analyzing that data and writing a lab report. Thus, I define technical language for this classroom community as the following:

> *Technical Language*: Any utterance that refers to the manipulation of physical scientific objects or abstract scientific concepts through use of science jargon or deixis and which is ratified by others as a display of technical knowledge.

Despite centralizing the construct of technical language in her study of engineering identity, Vickers (2007) does not define the term technical language. From the examples provided, the technical explanation and technical question sequences in Vickers (2007) contain lexical items related to science and discussions of the physical objects and abstract concepts students manipulate while engaging in their projects. In addition, Vickers (2007) found that "the ratification of explanations is the microinteractional move that allows team members to control the topic and ultimately ensure that their ideas become part of the ongoing project design" (p. 630). Thus, "technical language" both in Vickers' (2007) work and in this dissertation is the language of control in addition to being the language in which science concepts are discussed. Technical language is also "powerful" language (O'Barr & Atkins, 1980).[12] Because Vickers' (2008) study focused on advanced undergraduates, the physical objects of science in her study had scientific names. In the case of ninth-grade students, their lab materials were often crude (e.g., a cardboard box, a ruler). Thus, in the ninth-grade class we might expect to find fewer examples of lexical items marked as science terms for the materials in their investigations. However, this does not mean that students' conversations are devoid of scientific content knowledge. Rather, this demonstrates that in conversation, scientific content knowledge is embedded in the negotiation of power and social status.

The science terminology which one might initially look for as a reflection of expertise is only one component of "technical language," which also contains devices for indicating authority (epistemic stance markers), and exerting control (timing, frequency,

[12] I do not claim that technical language as I define it contains the exact linguistic features described by O'Barr and Atkins (1980) as powerful courtroom language. I use the term "powerful" language to demonstrate that technical language is not just "technical" because it is scientific but because it communicates a position of power, just as O'Barr and Atkins (1980) found that "women's language" was not related to gender as much as it was related to the lack of social status afforded to women. However, in this case, the relationship to science is maintained by the presence of scientific vocabulary and objects in the discourse and context.

and duration of technical explanations). As Vickers (2007) noted it is not just the linguistic content of the utterances but also the acceptance of technical explanations by other students that solidifies the explanations as indexes of science expert status. In many ways, the linguistic features of the "technical language" of *doing* science labs likely overlap with the language of any group project in which there is collaborative production. Demonstrating the scarcity of science lexical items in science classroom discourse reinforces the need for viewing expertise as a social position rather than simply an accumulation of scientific facts and understandings. Why then try to identify the "technical language" of science labs at all if it is likely to overlap with the "technical language" of group endeavors in general? I separate technical language sequences as a construct because I identify these particular interactions as places where science content knowledge is explicitly verbally negotiated. The other eight domains in Table 4.1 relate to content learning in more implicit ways as content knowledge is not verbalized (though it may be communicated) when a student retrieves a ruler, cuts a hole in a box, asks the teacher where the scissors are located, or tells another student to stop goofing around.

Over the course of Lab 1, Potato consistently articulated a science expert position in part by his use of technical language. In addition to providing technical explanations about phenomena unrelated to the lab task (inheritability of hot hands, use of Disney movies to treat autism, the definition of a cube), Potato also consistently produced explanations related to the lab task. In Extract 1 below, Potato starts his explanation for the third time after interruptions by the teacher and other students. Neither students nor the teacher requested this explanation from Potato. At this point in the lab students are in the early stages of developing their lab apparatus for investigating the relationship between light intensity and distance and modeling a $1/x^2$ (inverse square law) relationship. Utterance breaks in Extract 1 are listed at the end of intonation units to highlight the rising intonation that Potato (P) uses to invite Satan (S) to comment on his ideas. Deictic elements are bolded and described in more detail below.

Extract 1

1 P: So **it** could be like **this**?
2 With the light in **here**?
3 Right and in **there** like shining towards **it**?
4 But then well **it'd** be easier to set up?
5 You know cause **it's** just sitting there?
6 Like the light?
7 S: Yeah.
8 P: Or we could do **it** like **this**
9 And have the light be
10 **same sort of thing** just upside down.
11 S: Right and we could have ### to the top
12 P: [and there would be less light
13 S: [and that would there's
14 P: you could just see **it** a lot easier.
15 S: Yes:!=
16 P: =I kinda wanna do **it** like **that**
17 S: Yes:!

Extract 1 demonstrates Potato providing a suggestion for how the pieces of the apparatus (light, light holding support structure, and screen) should be set up in order to enable the students to systematically vary the distance of the light source from the screen onto which they are projecting light. The rising intonation after the statements in Lines 1-6 in combination with looking at her, indicate that Potato is inviting Satan to comment on his suggestions, which Satan does in Lines 7, 11, 13, 15, and 17. The bolded pronouns and phrases in the extract index physical objects (Lines 1, 3, 4, 5, 14), manners of placement (Lines 1, 8, 10, 16), and locations (Lines 2, 3, 5). The absence of scientific vocabulary does not mean that this is a nontechnical explanation. Technical explanations such as the one provided in Extract 1 were common among students articulating a science expert identity while students were setting up their experiments and designing their apparatuses.

The fact that Potato is manipulating scientific objects (a light box and its component parts) while speaking, that he provides this explanation unsolicited by his peers, that he restarts the explanation after repeated interruptions, and that Satan ratifies his explanation with an emphatic "yes!" in Lines 15 and 17 confirm an interpretation of this extract as "technical language" or the language of expertise despite the absence of lexical items related to physics.

In Lab 2, Gu Jun Pyo and Rico both occupy *science expert* identity positions during data collection in part by using technical language. These two students regularly disagreed briefly and then reached consensus. Extract 2 below demonstrates how these two students, Rico (RI) and Gu Jun Pyo (GJP) negotiate uncertainty while collecting data.

Extract 2

RI: So make our Line right there and start from there
GJP: Make the Line
RI: Manuel (3.5) make the Line right here. O:r we could just measure this
(5.5)
GJP: This is centimeters
(4.5)
RI: I would sa:y
GJP: Seven and a half?
RI: No (2.0) I would say eight but=
GJP: =eight
RI: No.
GJP: Let's let's see okay um: <*GJP leans in to look at the ruler and paper*> yeah it's eight.
RI: Okay.

With the exception of the term centimeters in Line 206 the language here does not appear to be technical. However, the act that students are engaged in negotiating is a technical scientific act. The students in this lab were measuring the differences in electrostatic force between a balloon and a packet of salt by placing the packet of salt on a scale and holding a balloon charged with static electricity at different heights above the salt packet.

It was important for students to accurately measure the distance between the balloon and the salt packet for each data point they collected. Ensuring the accuracy of this measurement was important to the overall success of the experiment. In Line 206 Gu Jun Pyo identifies the scale on the ruler (“this”), which is in centimeters. Lines 209-215 contain possible measurements given in numbers and various agreement and disagreement markers. In this case the science terms, the numeric readings, are embedded in a technical language sequence marked with uncertainty (Rico in Lines 208, 210 use of the modal *would* and *but*; Gu Jun Pyo in 209 with rising intonation) disagreement (Rico, “no” in Lines 210 and 212) and consensus (Lines 213-214 Gu Jun Pyo offers a reading without hedging or downplaying epistemic authority, Line 215, Rico accepts Gu Jun Pyo’s claim). The few lexical items linked to science in this extract are embedded in a sequence of talk that demonstrates how students negotiate uncertainty and disagreement and come to consensus. Engaging in the practice of explicitly negotiating science content was indicative of students occupying the science expert persona.

The examples of technical language occurring while students engage in setting up experiments and collecting data can be contrasted strikingly with the language students use when they are planning their writing, actually writing or planning presentations to the class. In Lab 3 Gu Jun Pyo (GJP) explains what she wrote for one section of the lab report. At this time students have determined how they will collect data but they have not yet begun collecting that data. Lexical items and phrases characteristic of science and academic discourse are bolded.

Extract 3

GJP: <*reading what she has just written*> We tied the two ends of the rope to two tables making sure that it was tight. We taped two **accelerometers** at different

> locations in the rope and I put in parentheses **eighty-nine and a half centimeters**. The **distance** between them would **account for the distance** and when we would flick the rope the **time the first accelerometer received as well as the second we would subtract** that would **serve for the change in time** then we would **solve for velocity** °or whatever°. <*looks right, looks left, hums to self, looks at board, keeps writing*> (03/09/15, Part 2)

In Extract 3 Gu Jun Pyo labels the physical objects of the lab using scientific terms when possible (e.g., the accelerometers). Gu Jun Pyo also describes how to manipulate the two measured variables, change in time and distance, to calculate a third variable (the object of investigation in this lab) velocity. This segment of speech more closely resembles what one might initially think of when considering science discourse and science language because of the presence of lexical items and collocations related to science (accelerometers, velocity, subtract, change in, account for, etc.). However, as mentioned above, these moments when students discuss what they are writing or should write make up a small percentage of the science discourse and technical language in the larger corpus. Science expertise in this classroom community is not only indexed by proficiency in using lexical items associated with science, but also with the skills required to negotiate uncertainty, express disagreement, express epistemic authority and the ability to direct others in how they should behave during labs. These speech acts that co-occur with students' use of the lexical items of science are summarized in Table 4.1 and are illustrated as they emerge in context in the analysis of Extract 7 in section 4.6 and in relation to the three focal participants' individual trajectories of participation in labs (the subject of Chapter 5).

This portrait of technical language and its relation to constructing the science expert identity model demonstrates what language learners and other students must learn how to do if they are to be perceived as *science experts* by their peers. Technical language is the discourse structure that contains lexical items, syntactic structures, and semantic relations (explicit or deictically referred to) related to science content. These are the places where science content is explicitly discussed and scientific meaning is negotiated. They are also places where students communicate positions of power and authority. Implications for what teachers and teacher educators could or should do with this information in order to improve educational opportunities for minoritized students in similar classrooms are discussed in Chapter 6.

4.3 The Good Student Identity

In addition to the science expert, another salient local identity model circulating in this classroom can best be described as the *good student* model. Just as the resources discussed above for constructing the *science expert* identity should be viewed as a flexible set of possible indexical relationships, so too should the communicative strategies and general behaviors associated with the *good student*. In addition it is important to point out that the science expert and good student identity positions are not mutually exclusive. Some students occupy both positions simultaneously (e.g., Potato in Lab 1), some occupy only one identity in a given lab (e.g., Satan in Lab 1), and others never occupy these positions (e.g., Manuel).

Unlike the science expert identity model, none of the interview questions that I asked specifically address qualities and behaviors of good students at the exclusion of science expertise. Thus, this model is best represented in interactional data.

4.3.1 Communicative Practices of Good Students

As depicted in Table 4.1, student interactions during labs demonstrated that good students ask technical questions, revoice technical explanations from the teacher and other experts, ask and answer questions related to task completion, issue directives to peers related to task completion, selectively ignore or negatively evaluate off-task behavior, positively evaluate on-task behavior, use materials in intended ways, confer with their lab partners, interact with the teacher as directed by science experts, and verbally express agreement with science experts. The following subsection further explicates how *good students* use technical language.

4.3.1.1 Technical Language of Good Students

Good students use technical language in the following ways (depicted in Table 4.1): paraphrasing or repeating technical explanations given by the teacher or science experts, clarifying what they are supposed to do with scientific objects, asking questions about the lab apparatus or data collection procedures, and when writing lab reports or presenting results.

In Lab 1 Satan consistently occupies a good student position in which she generally defers to Potato's scientific expertise. In Extract 1 (analyzed to demonstrate aspects of the science expert identity in Section 4.2.2.1) Satan responded to Potato's technical explanation for how they should set up the apparatus (i.e., the light box) with agreement "yes:!" (Lines 15 and 17). In Lines 11 and 13 Satan begins to repeat Potato's idea back to him. This repetition acts to clarify Potato's plan for Satan who agrees with the ideas presented by Potato. Immediately following Satan's (S) agreement, Potato (P) continues his technical explanation:

Extract 4

20 P: So we need to make something that'll hold it like this.
21 Now I was thinking we could just
22 S: So that means' you're gonna have to like tape or tape all
23 P: We could just go like this
24 S: Cause you can just connect it
25 Like you can just connect it
26 Like it's still
27 Like when it's hanging and stuff
28 You can
29 Cause those other wires are long enough that you can
30 keep the battery here right
31 P: Yeah
32 S: And you don't have to like
33 Suspend it through the top

Satan interrupts Potato in Line 22 to clarify her understanding of his plan (Lines 20-21). She then engages in her own technical explanation starting in Line 24 and comments in Line 32 that with Potato's suggested approach the students will not have to "suspend it [the light] through the top." In this extract Satan uses technical language in service of understanding Potato's plan for the apparatus. Rather than providing new suggestions for the structure of the apparatus, Satan offers agreement with Potato through her use of technical language. Potato accepts Satan's paraphrase of his explanation with "yeah" in Line 31. However, after a few similar exchanges Potato says in Line 106, "I'll just make it on my own," thereby indicating that Satan need not understand the details, that Potato will finish constructing the apparatus. In this scenario, Satan's uses of technical language are ratified by Potato as demonstrations of understanding for most of their conversation. Satan demonstrates expertise by paraphrasing Potato's comments and by expressing agreement with Potato's plan. Because Satan's expertise is essentially derivative of Potato's expertise, her comments index a *good student* identity as opposed to a *science expert* identity.

In addition to supporting science experts through technical explanations, good students also ask technical questions related to lab setup and data collection. For portions of Lab 1 Rose occupies the *good student* identity. Approximately 10 minutes after the exchange between Potato and Satan demonstrated in Extracts 1 and 4, Rose (R) and Potato (P) have the following exchange:

Extract 5

1 R: Is it going to be moving around?
2 P: No it's going to be moving this way.
3 R: No the light inside of it.
4 P: No the light is gonna be the same distance from the hole.

In this short exchange Rose asks Potato a technical question about the lab apparatus. In addition, she negotiates misunderstanding when Potato indicates that he interpreted her "it" in Line 1 to refer to something different than what Rose had intended.

These two examples demonstrate some of the ways that good students use technical language during labs. In one case, the student used technical explanations to demonstrate understanding of a *science expert's* suggested plan in an attempt to come to consensus about the plan and in the second case the student asked the *science expert* a technical question to clarify her understanding.

4.4 The Good Assistant Identity

The third identity model related to success that emerged in lab groups is the role of the good assistant. I first noticed this identity position while watching Manuel's participation in lab tasks. The term good assistant comes from Lab 1 (12/02/14) when Rico and Manuel were working together before other students joined their group. Rico explicitly labeled Manuel as a "buen asistente" or good assistant in Spanish. Although other students are not labeled as good assistants outwardly in other labs, this identity position exists implicitly in every lab group that I observed. Subsections 4.4.1 and 4.4.2 demonstrate how students co-constructed this identity model.

4.4.1 Communicative Practices of Good Assistants

Students who occupy the good assistant position use science-based lexical items only incidentally if at all, obey commands from good students and science experts, ask for permission before acting, solicit approval for their work from peers, use materials for intended purposes and often retrieve them for others, have limited interaction with the teacher, and do not verbally agree or disagree with their peers (Summarized in Table 4.1).

4.4.1.1 Technical Language of Good Assistants

Because good assistants don't regularly use technical language there are few examples in the corpus. There is one example of a *good assistant* providing a *science expert* with a requested term instead of a physical object. In the early stages of Lab 3 (measuring the speed of a wave) Gu Jun Pyo is engaged in a technical explanation to a new group member, Captain America. Prior to the introduction of Captain America in the group Gu Jun Pyo has served as the group science expert and OneDirectioner (OD in Extract 6) has occupied both the good student and good assistant positions. Gu Jun Pyo (GJP) starts to explain the lab to Captain America (CA) in Extract 6.

Extract 6

GJP: So we're tying it from here to here. And so like we have to find distance and what was it? <*turning to OD*>
OD: And time.
GJP: Time so ah to find our distance we're going to put two of these here. So we're gonna hold it really tight. <*GJP moves to the end of the rope that is opposite the*

> *table leg*> It's an awesome idea, we're going to hold it like this and we're gonna have two so when you put a force on it like this we're going to send a wave to the first one and then we're going to send a wave to the second one <*gesturing to the two accelerometers on the rope*> and from that time that's gonna serve as our time. (That's how we're gonna get our time measured). Yeah and ah distance (like) is gonna be from here to there. I'm not sure if I explained it right.

In Extract 6 Gu Jun Pyo asks OneDirectioner for a term, time, which is one of the variables that the students are measuring in this lab. In the good assistant role OneDirectioner provides the object needed by the expert, in this case, a linguistic rather than physical object. A few minutes later the class comes together in a whole class discussion about the lab setups. Gu Jun Pyo serves as the group expert conveying the group's plan to the class with teacher prompting.

4.5 Three Identities in Practice

The extract below from Lab 1 shows Potato articulating a *science expert* position, Satan articulating a *good student* position, and Rose and OneDirectioner articulating *good assistant* positions. Extract 7 provides the first sample of interaction between these participants in the corpus. The analysis of Extract 7 is preceded here by a brief summary of what occurred in class prior to this interaction.

The class period starts with announcements and a class discussion about grade-related permission slips for a field trip and other topics related to midterm grades. The teacher then transitions to talking about the lab that students are working on. Mr. H asks for a student volunteer to review for everyone what students should be doing in this lab to model the relationship between light and distance. Only Potato raises his hand and the teacher calls on him, "we're trying to get our data to be as close as possible to the equation." The teacher asks a follow-up question, "and what methods are we going to employ to do that?" Potato provides a short answer about the materials they are using and the teacher elaborates. Potato interjects once to add to what the teacher is saying and the teacher validates the interjection with "yes" and continues. The teacher then walks to the back of the room and retrieves a light-box (model lab setup). The teacher shows the box to the class and talks about issues with the lab setup and provides options for how students could and should solve these problems.

Potato again interjects and asks a technical question, "could you just do it not in centimeters and just do it in units?" The teacher answers, "then you would have to use the distance would also be in the same units. That's the thing they have to correspond to each other or it ends up screwy." The teacher continues with an explanation of how to affix graph paper to the light-box, how to mount the light to the box, how to center the light source with the hole in the box. The teacher then explains why these approaches work well. The teacher asks if there are any questions and Potato asks a question, "can you just hang the light instead of just propping it up?" The teacher replies, "It'd be hard to keep it consistent if you just did that. You'd be running the risk of some small inconsistencies screwing up your data." The teacher continues giving instructions about the lab setup holding up a light-box and clarifying what students should be measuring, the "amount of space that light is spread over." The teacher then demonstrates what students should expect to see in the graphs of the data. He also says they'll talk more about the graphs tomorrow. The teacher shows students that there are drawings of what the light-boxes should look like on the smart board. He then makes announcements about where to find the materials in the room and what to do with them at the end of class. The teacher then sets students free to work in their groups.

I include this description of the whole class setting to highlight Potato's role as a good student in this environment. He is the only student to ask the teacher any questions, and furthermore, they are all technical questions related to the lab set up and data collection process. In the whole class setting the teacher is the *science expert* and Potato acts as a *good student*. Potato transitions to being the local *science expert* as soon as students are allowed to work in their groups. Potato's (P) lab group consists of Rose (R), OneDirectioner (OD), and Satan (S). As soon as students are set free, Satan asks Potato where their boxes are and he retrieves them. Extract 7 starts when Potato returns to the group with their light-box.

Extract 7

P: So
S: Ours is ### (2.0) wow why are you taking it off?
P: Eh I just want to get rid of this little guard thing cause he said that it's not actually that hard to see °so might as well just°
S: Okay.
(3.0)
P: It'll just get in the way so, move this
S: mrrrrrrrrr <*cat sound*>
P: Wenh wenh wenh wenh wenh wenh, I feel like maybe we should get another piece cause this isn't very flat especially when it's up there. No so we could like get a piece of this paper and get like make our own paper. Or we could even just write it, put it on the paper that's a good idea.
S: What is @@? =
P: =Get=
S: =You keep changing your mind @@ [as you're talking to me. <*smiling*>
P: [@ sorry. I'm sorry.
S: It's like or maybe we should or maybe hunh? mm that's a good idea <*funny voice*>
P: wow <*talking quietly to self*>
R: Lost. (1.0) Can I make the little box thing?
P: Wow w-well you could make a b-a square. You wanna make a square?
R: @@ yay making a square @@
P: Yay making squares ow.
S: Ow @@
P: Ow
S: Ow
P: O:w (4.5) could you just cut, see where this mark is?
R: No I don't.
P: Cut that like that and the[n:
R: [Where's the other mark isn't it that one?
P: Wait there yeah.

R: [Okay
P: [Just cut it, cut a square out.
R: ## scissors ##
OD: Okay I will get
R: Hunh?
P: Say what?
OD: I will get the scissors. ## okay?
------*13 seconds* ------
P: eee-unh ee-unh ee-unh
S: Okay. That’s enough.
P: Wait now we need to cut the hole. Go get him to cut the hole.
R: What?
P: <*whispers something inaudible*>
S: @
P: <*whispering inaudible*>
S: you have to make a little box to mount the light on
R: [Yeah
P: [Yeah we could do that yeah just go get give him a couple of minutes it’ll be hard for him to cut the hole with all the people up there.
S: Wait don’t we have to mark the center of it?
(3.0)
P: It’s not very accurate anyway @@
S: Yeah it really isn’t.
P: °It’s not even a square°
S: You: go.
P: How should we mark the center of it?
S: I’ll mark the center and you go get him to cut the hole. Ah that looks about good @@ <*high pitched voice*>
P: @@ We could actually measure it we have a ruler. We have the technology.
S: Yes we do. Go get me another ruler, Potato.
P: hunh?
S: Go get me another ruler. No, Rose is using that one
OD: I’ll go get one. I’ll go get one.
P: This is big enough.

Potato articulates a science expert identity by initiating the task; he retrieves the light-box and starts making changes to it in Line 1 when he says “so.” Potato does not ask for permission to make changes, nor does he ask the opinion of the other students before making changes to the box. In Lines 3-4 and 7 Potato provides a technical explanation for what he is changing on the set-up. In Lines 9-12 Potato narrates his thoughts out loud related to changes on the light-box thereby providing another technical explanation. In Line 21 Rose asks permission from Potato to make “the little box thing” and Potato grants her permission instead to make a square. Potato provides instructions to Rose on how to do her task in Lines 22, 28, 30, 32 and 34. Potato also controls workflow by giving a command for someone to “go get him to cut the hole” (Line 43) and by indicating in Lines 50-51 that the students should wait to ask the teacher to cut a hole for them because he is busy (the teacher previously indicated that only the teacher should cut one particular hole). These comments could be seen to index a good student identity as opposed to the science expert identity because the content of the comments does not relate to scientific meaning or accuracy. This demonstrates how students may simultaneously occupy both positions. In Lines 54 and 56 Potato responds to Satan’s suggestion to mark the center of the screen with comments on the accuracy of a feature of the light-box. Satan then softly interjects a command to Potato to go up to the teacher’s desk to get the hole cut (Line 57) which Potato ignores. In Line 58 Potato expresses uncertainty for how to mark the center of the screen by posing a question to the group. Potato signals that anyone could answer the question based on use of the pronoun “we” as opposed to directing the question to an individual. Satan takes the opportunity to nominate herself to mark the center and she nominates Potato to go get the hole cut by the teacher (Line 59). However, the goofy voice when making a spoof evaluation of a proposed mark and her laughter as she looks at the screen indicate Satan’s uncertainty about how to accomplish this task. Potato suggests that they use a ruler in Line 61, which he characterizes as “technology.” Satan responds by telling Potato to get her a ruler (Line 62). It is interesting that Satan has a brief pause at the end of her command before she says Potato’s name, thereby nominating him to get her a ruler. Potato is almost never positioned as a good assistant and the retrieval of materials is something that good assistants are asked to do. Potato responds with surprise in Line 63 causing Satan to repeat her command in Line 64. Potato tries to pass Satan a ruler that is on the table but

Satan tells him that that is Rose's ruler (Line 64). In Line 65 OneDirectioner offers to get the ruler. Potato resists being positioned as a good assistant by delaying his response to Satan's command, then partially following the command, then not following the command until another student, OneDirectioner, steps in to get the ruler. Potato's actions point to him as a *science expert* and a *good student* but not a *good assistant*.

Satan negotiates her position as a good student in a variety of ways. First, she asks a technical question in Line 2. Second, she criticizes Potato's communication skills in Lines 13, 15, and 18. These moves are particularly interesting because they do not result in Potato re-explaining his thoughts. Rather, Potato apologizes and that is the end of that component of the conversation. This begs the question of whether or not Satan's goal was to characterize Potato as a bad communicator or to actually inspire him to provide a revised technical explanation. Satan's acceptance of Potato's apology seems to indicate that she is not particularly concerned with being given a revised technical explanation in this case. Third, Satan monitors and negatively evaluates potential off-task behavior (Line 42) though she also participates in silly noise making with Potato at other times (Lines 25-28). Fourth she provides two reminders to Potato about the teacher's instructions, one in command form (Line 48) and one in question form (Line 52). Because the teacher had just made announcements that students should do the things that Satan suggests, her comments do not index scientific expertise but rather attention to the teacher and following instructions. Fifth, in Line 55 Satan agrees with Potato's evaluation of accuracy. Sixth, in Lines 57, 59, 62 and 64 Satan issues commands to Potato related to who should do what (Lines 57, 59) and the ruler she wants Potato to get for her (Lines 62, 64). These commands serve as attempts to control the workflow and materials in the lab but not the scientific content of the lab. It is interesting to note that Satan's command in Line 57 could be seen as a response to Potato's command in Line 43. As in, by disagreeing about who should go get a hole cut by the teacher and which ruler Potato should retrieve for her, Satan carves out a social role for herself as in charge despite not being the resident *science expert*. Satan's actions demonstrate that she is concerned with following the teacher's instructions, staying on-task, understanding what Potato is doing in the lab, and controlling the flow of work and materials in the group. Taken together these behaviors point to a *good student* identity.

Lastly, the actions of Rose and OneDirectioner demonstrate the *good assistant* role. In Line 21, Rose asks permission from the resident science expert (Potato) to make a component of the lab setup. Though she expresses some dissatisfaction with her task (Line 23) by making fun of the menial task, she nonetheless does what she is asked. Rose clarifies her understanding of what she is supposed to do in Lines 29 and 31 by answering then asking a clarification question. When Rose indicates that she needs scissors in Line 35 OneDirectioner offers to retrieve them for her. In Line 44 Rose responds to a command from Potato with "what?" perhaps to delay responding to the command, or to clarify who the command is directed to but Potato does not respond to her and she does not ask for further clarification. In Line 49 Rose agrees verbally with Satan's reminder about the need to "make a little box to mount the light on." However, Potato also responds at the same time with a longer turn at talk and Rose does not say anything more on this topic or any other topic in this extract. Rose indicates that she is a good assistant by asking for permission before working on the lab setup and by following instructions. It is interesting, however, that she also expresses some dissatisfaction in her role. This is evidenced by her comment of being "lost" in Line 21 preceding her request to do a menial task and by the fact that she does not simply retrieve the scissors that she needs, instead commenting on her need which OneDirectioner then fills. In addition, Rose's affirming "yeah" in Line 49 demonstrates that she is listening to Potato and Satan and that she is interested in participating in the construction of the lab setup. These signs may point to a desire to be seen as a *good student* or *science expert* despite being relegated to menial labor.

In addition to her offer to retrieve scissors (Line 39) OneDirectioner also offers to retrieve another ruler in Line 65 OneDirectioner's role can indicate only the good assistant position. She is listening to the needs of her peers and offering to help when there is a task that she knows how to accomplish with confidence – retrieval of materials. It is important to note that OneDirectioner does not retrieve materials as a result of commands but rather in response to the needs expressed by her peers. This behavior demonstrates that OneDirectioner is listening to her peers and is willing to jump in and take the initiative to do something if the possibility arises.

The brief analysis of the identities articulated by four students in Extract 7 demonstrates what the *science expert*, *good student*, and *good assistant* identities look like in practice. I refer to these as models for success because failure to occupy one of these roles leads students to be negatively sanctioned by their peers and the teacher (e.g., Satan "disciplining" Alexander in Lab 1; girls chastising Gu Jun Pyo in Lab 3). This is why I identify the good assistant role as one of success in the classroom despite the fact that it is not necessarily linked to good grades on major assessments such as tests. Good assistants are seen to be participating in the task, they stay on-task, and they generally complete the work given to them and care about their quality of work.

4.6 Expertise Hierarchies

As demonstrated above, students exhibiting archetypal representations of the three identities end up in a hierarchical relationship when engaged in scientific inquiry projects. The *science expert* is ranked the highest in the expertise hierarchy, followed by the *good student*, and in the lowest position, the *good assistant(s).* During peer interaction individual students exhibit characteristics of all three identity-positions or only one identity position depending on a variety of factors. Looking at students' participation across lab tasks provides more information about their socialization into or out of scientist identities.

Table 4.1 Summary of Identity Models for Success

	Science experts	**Good Students**	**Good Assistants**
Technical Language Sequences & Science Vocabulary	Provide technical explanations with or without science vocabulary both in response to peer questions and unsolicited about the lab and about science topics that are nonlab/physics class topics. Answer questions & provide explanations related to lab reports. Uses of scientific vocabulary are purposeful and reflect scientific understanding.	Ask technical questions about the details and rationale for the lab setup and method of data collection. Paraphrase the technical explanations of experts. Answer questions & provide explanations related to lab reports. Uses of scientific vocabulary are purposeful.	Ask for clarification about what to do or what has been done during lab setup, data collection, and lab report writing. Uses of scientific vocabulary are incidental if present.
Directives & Peer Nominations	Issued to peers related to lab setup and data collection (retrieval of materials, who should do what when, etc.)	Issued to peers for actions related to lab completion and work flow (retrieval of materials, who should do what when, etc.)	Obey commands, sometimes nominate intended recipient of question.
Permission	Grants permission	Grants permission	Asks for permission
Silence	Selectively ignore off-task and on-task comments	Selectively ignore off-task behavior	Speak about the lab only in response to commands or to ask questions
Verbal Evaluations of peers	Negative and positive evaluations of peer ideas and performances related to consistency and accuracy in lab setup, data collection, and report writing tasks	Negatively evaluate off-task behavior. Positively evaluate on-task behavior.	Solicit approval and evaluations of own performances from experts and good students
Materials use	Control and manipulate materials and lab computers without requesting permission	Use materials for intended purposes. Sometimes control the flow of materials	Use materials for intended purposes under the direction of peers
Negotiating meaning and uncertainty	Often confer with other experts, leave group if necessary to talk about what to do and how to do it. May talk with other experts about science topics not related to the lab	Confer with lab group members.	Does not verbally negotiate scientific meaning with experts and good students.
Teacher interactions	Directs questions to the teacher and serves as the group spokesperson in interactions with the teacher. May engage with the teacher in science-related conversations that do not relate to the lab	Directs some questions to the teacher, sometimes after being told to confirm information by a student expert.	Limited to no interaction with the teacher.
Stance-taking	Verbally disagrees or agrees with the suggestions of other group members and does not shy away from disagreement about science content.	Verbally disagrees or agrees with the suggestions of other group members, often agrees with the suggestions of science experts	Does not verbally agree or disagree with peers. Does not take a stance.

Table 4.2 Student Interview Comments Organized by Theme

Theme	Student Comments
Interest in science (6 students)	"She seems like more interested and stuff like that" *– Rose (Individual Interview, 01/28/15)* "If they would start a conversation talking about something related to science" *– Alexander (Individual Interview, 03/23/15)* "I love learning about science and I just sort of love knowing how stuff works" *– Captain America (Individual Interview 03/12/15)* "I always think about how stuff works so that's something a lot of scientists do" *– Potato (Individual Interview, 02/03/15)*
Demonstrated ability in science (2 students)	"On the test he got like 100. He knows a lot. Like every time the teacher calls on him he's like prepared and stuff" *–GJP (Group Interview, 02/10/15)* "She understands stuff easier" *– Rose (Individual Interview, 01/28/15)*
Participation in science communities (2 students)	"Um Captain America, I think she does a lot, she's been doing science fair" *– Alexander (Individual Interview, 03/23/15)* "I know I'm not right but when you think of science you think of in a lab." *–Rico (Individual Interview 03/24/15)*

Table 4.3 Self-Identification and Peer Identification as a Science Person

Participant	**Self as science person (Y/N)**	**Number of students who identified this person as a science person**
GJP	Y	1
OneDirectioner	N	0
Rose	Y	0
Potato	Y	4
Satan	Y	0
Alexander	Y	2
Rico	N	0
Manuel	---	0
Captain America	Y	3

CHAPTER 5

RESULTS: THREE LANGUAGE SOCIALIZATION PATHWAYS

This chapter describes the socialization pathways of three Latina students across the three science labs that served as the corpus for this study. The chapter answers Research Question 2: (a) What pathways of socialization do three bilingual Latina students undergo while participating in science inquiry labs? (b) How do these pathways relate to students' language and science content learning? The analyses center on student interview data and discourse data taken from the lab settings. Each description of a student's pathway relates the social positioning that she undergoes to her language and content learning opportunities.

5.1 Rose

5.1.1 Interviews

The information summarized here draws from two individual interviews with Rose, one in January 2015 and one in May 2015. This section demonstrates how Rose described her language practices inside and outside of school and her prior experiences with learning science. When combined with discourse data, the perspectives Rose shared in interviews provide a more holistic representation of her pathway of social identification.

Rose is a 14-year-old Spanish-English bilingual student whose family is from Mexico. Rose was born in the United States. She enjoys competitive swimming and participates on teams for her school and her community. One of the things Rose likes about SFAA is the extracurricular outdoor activities organized by the school. She has family in various western and southern states, and Mexico and she grew up visiting her relatives in Mexico during the summer. Rose reports speaking Spanish at home with her parents and with some of her friends, depending on their language backgrounds. Towards the end of the study Rose was planning her Quinceañera. When asked about how she learned about and started attending SFAA Rose reported that her father used to work at the school:

> Well my dad used to be working here when he, as a custodian. So he would me and my mom would like bring him lunch and stuff here so I like sometimes during the summer I would like come here hang out with him and help out and like during the winter also so I started learning and I also started liking the school. (Individual Interview, 01/28/15)

This quote demonstrates how Rose learned about SFAA and why she began attending the school in sixth grade. At the time of the study Rose's father worked at "the school district" and her mother worked at a superstore.

5.1.1.1 Science Classes and Learning Science

As documented in Chapter 4, Rose reported that she considers herself to be a science person; she also told me that physics was her favorite ninth-grade class. At the time of her first interview Rose had recently completed a lab with Potato, Satan, and OneDirectioner, and she reported that she liked working in this group because, "They actually really help understand. They like focus. Like if you don't understand an equation they like help you through it. Like different ways. So it helps understand a bit more." When asked how she would describe herself to someone who does not know her well she said that she has "two sides"; and that "I'm super quiet at school but at swim I'm like the loudest, and [I'm] nice."

In Rose's second interview she conducted the card sort activity described in Chapter 3. Rose identified the following as characteristics of good science students: participating in class discussions, solving problems, asking good questions, explaining your thinking, writing well and like a scientist, analyzing data, and working well with others. Of these behaviors Rose related four of them to lab practices. She described solving problems during a lab as fixing things "if something goes wrong," and she related writing well to writing good lab reports. In addition Rose related asking good questions and working well with others to the lab context. When asked what working well with others looks like in science class Rose provided the following answer:

> Rose: it's making sure that your peers understand what you're what we're learning about what we're talking or yeah
> Sarah: okay so how do you know that's important in this class? Is this something that you feel like Mr. H has talked about or is it just something that you feel is necessary based on the way the class operates?
> Rose: um I think it's just a normal thing a routine that we usually do it's like do you understand what you're doing and it's like making sure that you explain them what you're doing so yeah

Rose's comments here demonstrate that she feels that people in groups are good science students when they ensure that all group members understand what is going on. This response related directly to Rose's description of asking good questions, "like helping questions like for others like just with a group like small group I can't do it with a big group huge group. But just like helping questions to help them understand." These responses indicate that Rose's conception of asking good questions relates directly to her goal of having all students in the lab understand what is going on. When I asked Rose to identify the top three characteristics of good science students she identified: working well with others, explaining your thinking, and solving problems. By Rose's descriptions of these behaviors all of them relate to performances in lab tasks.

When I asked Rose about "talking like a scientist," which was a behavior she originally placed in the "maybe" pile when sorting behaviors of good science student, she said, "I don't know it's like we're not expected kind of to exactly use big words the words you would usually use like when you're researching something so I really didn't know if it would be yes or no. I just put maybe." This comment, along with the practice of asking good questions to facilitate group members' learning, supports the description of the *good student* model provided in Chapter 4. Good students in the lab setting do not frequently use science vocabulary verbally. Rose's conception of the good science student does not overlap directly with the *science expert* model. By her description, it is possible to be a good student without being a science expert.

Lastly, when asked to report the top three behaviors she would like to see valued in her ideal science classroom Rose listed asking good questions, writing well, and working well with others. This response, taken in the context of her descriptions above, indicates that she values group work for her ideal science classroom environment. As mentioned previously, these interview questions predated the analysis of social types presented in Chapter 4. More importantly for answering the current question, these statements from Rose provide a lens with which we can view her classroom participation in labs in the following subsections. Before moving to a discussion of her behavior in physics labs it is prudent to mention the way that Rose described her linguistic and cultural practices surrounding speaking Spanish and English in school and at home.

5.1.1.2 Speaking Spanish and English in School and at Home

Understanding Rose's language practices and social experiences inside and outside of school provides context for interpreting her discursive behaviors in physics class. In her final interview Rose mentioned feeling stressed because it was the end of the school year. When I asked Rose follow up questions related to her end of year stress, she mentioned a class project that she was completing with OneDirectioner in her history class. In the project students had the opportunity to interview people who have had life experiences in different types of organizations. Rose selected a Latin American organization for her group. When I asked her why, she replied:

> I don't know I felt like cause I'm in the same group with OneDirectioner so I was like well it's something with Latin so I was like maybe we could like learn more about it since we usually don't learn more a lot of stuff about Latin America Latin people so I was like let's just do that one and then we'll learn and talk with people that speak Spanish and then it's gonna be much easier for us. (Individual Interview, 05/2015)

This quote reflects Rose's desire to learn more about Latin America in her classes and to use her Spanish language skills to complete an academic project. In addition to her family's connection to Mexico and her interest in Latin America, Rose also mentioned experiencing some cultural conflict as a result of navigating U.S. and Mexican culture. The following excerpt comes after Rose has described that when she goes to Mexico she doesn't know very much about Mexican history or holidays and Sarah has asked if this is difficult for her.

> Rose: I don't know I think that my family got pretty much used to that I don't know anything about the history of Mexico. And they just got used to it and um I was literally talking to my parents cause my parents were talking to my brother my older brother and I was just like why doesn't he like look to you eye to eye when you're talking to him and they're just like it's like it's like bad manners if you talk to someone in Mexico eye-to-eye it's like they might want to punch you or something so I'm like oh okay! I learned something new!
> Sarah: So do you practice not looking people in the eye in Mexico like oh I'm not trying to be aggressive!
> Rose: Yes yeah and it's like and then like the whole entire story came up with my parents it's like well we learn we taught your brother we grew up with the same traditions and everything and then you're here and you don't know much of the traditions.

This passage demonstrates that Rose continually participates in multiple cultures and linguistic communities when navigating her home and school life. Although her explicit statements during interviews do not demonstrate cultural conflict per se, I argue later in this chapter that her identity as a Latina and as a Spanish speaker is in some ways in tension with her ability to be recognized by her peers as a *science expert* or *good student* in science labs. Overall, Rose reported positive feelings about SFAA, her teacher, and science in two individual interviews. The interviews also revealed details about Rose's orientation to Mexican culture and the Spanish language.

5.1.2 Lab 1 – Rose as a Good Assistant and Aspiring Expert

During Lab 1 an accumulation of signs in the narrated events of the work students were engaged in pointed to Rose as fulfilling a *good assistant* role in her group despite her attempts to occupy *good student* or *science expert* roles. As a result, Rose was denied access to the understandings being discussed and demonstrated by the *science expert* and *good student* in the group.

In Chapter 4, Extract 7 I argued that Rose occupied a *good assistant* role at the beginning of Lab 1 by asking for permission from an expert before acting and doing what was asked of her by that expert. I also indicated that Rose might be unhappy in the good assistant role because of her comment that she was "lost" (Line 21) and because of the way that she mocked her menial task in Line 23. In addition, Rose (R) does not retrieve her own materials in this exchange, instead allowing OneDirectioner (OD) to retrieve them for her. A few minutes after the exchange in Extract 7, Satan (S), and Potato (P) leave the group temporarily. When they return they have the following exchange.[13]

Extract 8

P: I actually put it in backwards but it's okay.
(3.0)
R: No, Potato, it's not okay. (6.0) There! Almost done.
P: Almost [I thought you were going to be done now.
R: [pretty straight right?
P: No it looks not straight at all.
----*deleted comment in unintelligible side conversation*----
R: Now the other side.
P: I think this is gonna work better [this this whole because
R: [Yay I'm almost done but not
P: <*looking at Satan*> We only have to worry about a little bit of light getting in cause we're just looking at where the light comes out. S-I was thinking, you know normally we would just like measure a bunch of distance and put it on the distance and measure where=
R: Potato
P: [it is? It would be a lot easier
R: [Potato Potato slow down
P: because a little centimeter you're only going to be measuring like a hundredth of a centimeter <*Potato does not change his rate of speech perceptibly*>
OD: @@
P: or something crazy like that? You could um estimate=
OD: La primera vez que le conoci? <*Eng: The first time I met him*>
R: Yeah
OD: No lo entendio, [pero no <*Eng:I didn't understand him but,*>
R: [I still feel like that @
OD: Yeah, pero no lo entiendo y esta significa que es muy [###### <*Eng: Yeah but I don't understand and this means [something] is very*>
S: [say that whole thing one more time <*looking at Potato who has just finished the technical explanation started in line 19. Potato was talking while Rose and OD were talking. His turn at talk picking up from ln 19 was: it would be a lot easier to just put it and aim it up to centimeters and then measure the rest*>
P: So right now how we have it

[13] This conversation takes place in close proximity to the technical explanation by Potato described in Extract 1 in Chapter 4.

R: No we no cause I still don’t even understand him.
P: is
S: °No ha-blo in-glais° <*pronounced with English phonology*>
P: No ha-blo in-glis <*pronounced with English phonology*>
S: In-gles <*pronounced with English phonology*>
OD: I was saying the first time that I met him I didn’t understand him.
S: @@@@@
P: ##
OD: @@@
(7.0)
P: Well just that um (2.5) it might be easier to to
R: @@
P: move it until the light matches up to each centimeter grid out you know? (1.0) right? (2.0) and then and then measure the distance <*looking at Satan*> instead of measuring the distance and then seeing the light? Measuring the light and seeing the distance. <*this is a perceptibly slower rate than Potato’s earlier comments*>
S: [Can we do that?
R: [Potato, what you can do
P: I think so, it’ll just be back
R: Is like how far does it go? How far do you want it to go?
P: I don’t know, like there.
R: Like there? So start making <*Satan walks away*>
P: No
R: A rule that centimeter
P: I’ll mark this up, I’ll mark this part
R: That’s what I’m saying! <*Potato starts manipulating a piece of the box handed to him by Rose*>
P: Okay fine.

Rose indexes a *good assistant* identity in two ways in this extract. First, in Line 5, she invites peer evaluation on her performance in creating a piece of the lab setup by asking for confirmation from someone else that she has made the piece straight enough. Potato issues a negative evaluation of Rose’s performance but this is likely a response to her negative evaluation of his performance in Line 3, as opposed to representing real concern for the accuracy of the straightness of the object in question. The lack of follow-up conversation in how to improve the part further supports this interpretation. In Line 53 Rose asks Potato for clarification in how far apart he wants two parts of the setup to be oriented. Instead of making a decision Rose specifically defers the decision making to the group’s science expert, Potato. In addition to constructing herself as a good assistant in the ways just mentioned, Rose’s peers also position her in this role despite her attempts to challenge this social positioning.

One could interpret Rose's comments in Lines 1-3 as an attempt to act as a science expert by negatively evaluating a peer's performance. However, two aspects of this exchange work against Rose's attempt. First, Potato himself points out the scientific error (putting something together backwards) that he committed, not Rose. Thus, Rose's comment on the unacceptability of this act does not index expertise. Second, Rose follows her statement with a question that indexes assistant rather than expert status. The next time in which Rose attempts to renegotiate her social position in the group comes in Lines 15 and 17 when she asks Potato to slow down. Potato frequently talks quickly while he is explaining his ideas and this is one of at least two times in this lab that I witnessed Rose requesting that he slow down. If Potato were giving Rose instructions when she issued the request we might interpret her request as a clarification request, which would then reinforce her good assistant role. However, in this instance Potato is explaining an idea for the lab setup to Satan. By asking Potato to slow down Rose makes a bid to enter the conversation so that she might understand the plan for the lab. Potato rejects Rose's request by not slowing down, and in Line 18 he continues with his explanation to Satan. OneDirectioner instead responds to Rose by commenting to her in Spanish (Lines 22 and 24) that she couldn't understand Potato when she first met him. Rose responds to OneDirectioner in Lines 25 and 34 that she still does not understand him. I argue that these bids to participate in the negotiation of science content are indicative of the *good student* identity. By rejecting Rose's attempts to identify herself as a *good student*, Potato continues to relegate Rose to a *good assistant* position and he denies her access to negotiating science content and language.

It is also important to note that before continuing his explanation of science content in Line 46, Satan responds to OneDirectioner's use of Spanish and Rose's comment in English in Line 34 with Mock Spanish (Hill, 1999; 2008) in Lines 36 and 38. Potato also engages in Mock Spanish with Satan in Line 37. Both Satan and Potato use "hyperanglicized" (Hill, 1999) pronunciation in order to mock Spanish and by logical extension, the Spanish-speakers in the group. A full discussion of how Mock Spanish functioned in this classroom during lab groups goes beyond the scope of this dissertation. However, there were multiple instances of Mock Spanish in this lab group over the duration of Lab 1. I discuss the broader implications and potential ideological consequences of Mock Spanish in this classroom in section 5.4. In the immediate context following the instances of Mock Spanish, rather than responding explicitly to the content of Rose's original request (to slow down) or OneDirectioner's comment about not understanding him, Potato continues his scientific explanation (Lines 44 and 46-49). Potato's technical explanation in Lines 46-49 was delivered at a slower rate than his earlier comments. However, he still directed his comments to Satan and her lack of responses to his comments after pauses in Lines 46 and 47 indicate that he was looking for confirmation from Satan that he did not receive. Thus, the change in his speech rate could be attributed to his desire to communicate with Satan as opposed to an indirect response to OneDirectioner's and Rose's comments. Thus, Rose and OneDirectioner are positioned both as assistants and as students who are not able to speak English as well as their peers.

In Line 51 Rose attempts to position Potato as an assistant by directing a command to him about what he should do for her. This act would position Rose as an expert. However, she follows the start of her command with a deferential question to Potato (Line 53). Rose continues her command in Line 55 and Potato rejects this positioning directly by saying “no” in Line 56 and by revoicing Rose’s command as a narration of his own self-directed activities (Line 58). Taken together Rose’s moves in this extract demonstrate her positioning as a *good assistant* and her aspirations at being recognized and allowed to participate as a *good student* or a *science expert*.

In the conversation following Extract 8, Rose and OneDirectioner work to construct the outer structure of the light box while Potato and Satan discuss how they will set up the lab. At one point Rose interrupts them to ask if they (she and OneDirectioner) should still be making the box. Satan tells Rose to continue making the box and she then continues talking to Potato trying to understand his idea for the lab setup. It was not unusual for Satan and Potato to be engaged in one conversation while OneDirectioner and Rose engaged in another conversation. Although Rose and OneDirectioner sometimes spoke in Spanish, they overwhelmingly used English in this lab even when speaking only to each other. Later on during this same class period Rose found out that one of the materials she constructed in service of Potato’s vision for the lab setup was not needed. She expresses frustration at having wasted her time on building this item for no reason. All of this positioning took place during the first session that I recorded for this lab group. Rose’s participation in Extract 8 shows her challenging her positioning in the group as a good assistant, and her attempts to be recognized as a good student or science expert. In the two weeks that followed the lab period described above Rose was continually folded back into being positioned as a good assistant despite repeated attempts to participate as a *good student* or *science expert*.

The students in Lab 1 constructed and continually rearticulated the following expertise hierarchy: Potato→ Satan → Rose → OneDirectioner. The analysis of Extract 8 reveals that these negotiations served to exclude certain participants (in this case, Rose and OneDirectioner) from talking about science content and using science language. In addition, the references to OneDirectioner and Rose's use of Spanish and their perceived inability to speak English at the level of their peers were intertwined with the positioning that maintained their status as *good assistants*.

5.1.3 Lab 2 – Rose as a Good Assistant and Aspiring Expert

In Lab 2 Rose's partners were OneDirectioner and Potato. As described in Chapter 3, this lab required students to measure electrostatic force using a charged balloon and packet of salt on a scale. Students completed the lab in one class period. From the beginning of Lab 2, Rose attempted to first prevent and then contest her positioning as a *good assistant*. However, she also positioned herself as a *good assistant* in multiple ways thereby ensuring that she had some role participating in the lab. In addition to negotiating social roles related to the good assistant, good student, and science expert identity models, the students in this lab also positioned themselves with respect to language background. As in Lab 1, explicit references were made to OneDirectioner's and Rose's Spanish speaking ability and Potato's lack of Spanish knowledge. I argue here and in other sections that the social positioning students engaged in related to race and language background intersected with the successful student identities.

The lab began with Potato asking, "okay, guys you ready?" To this question Rose responded with a command, "I think you should get the balloon Potato." This was Rose's first utterance in this lab and in it she attempted to position herself as someone who nominates others to do tasks. However, as with many of her attempts to command Potato, he does not abide by her request. In the first 25 minutes of the lab Rose issued 12 commands to her peers; 75% of these were rejected either verbally or through the person ignoring the command. During this same 25-minute time frame, Potato issued 17 commands, 82% of which (i.e., 14 in total) were accepted and executed by Rose and OneDirectioner. In addition, on multiple occasions Rose initiated short off-task conversations with her peers and she then also initiated the shift back to lab-related discussion with a command. These practices indicate that Rose was attempting to demonstrate expertise or control although her attempts were either unratified by her peers or later undermined by her own epistemic stance-taking behaviors.

It was not uncommon for Rose to indicate her lack of knowledge of what to do. Approximately 5 minutes into the lab before students had a clear setup Rose was testing out the lab materials when OneDirectioner asked her, “so how are we going to do it?” Rose responded, “I don’t know” and did not follow this comment by articulating any ideas for the lab. This move positioned Rose as not having the requisite knowledge to serve as the group expert. OneDirectioner responded by asking, “Where’s Satan?” This response is an indication that she was then looking for someone else to provide her with instructions because Rose was not able to do so. As we saw in Lab 1 (Extract 7 analyzed in Chapter 4), Satan often occupied a role of telling students what to do, directing workflow and asking Potato to clarify his thinking. This comment from OneDirectioner is best interpreted as her searching for someone who could serve as a guide in telling her and Rose how to proceed with the lab. Although the video recorder was not aimed at the group at the time that OneDirectioner and Rose had this conversation, the lack of verbal contribution from Potato indicates that he was likely away from the group's lab station at the time of the conversation.

Extract 9 picks up after the conversation just described between OneDirectioner and Rose. This extract demonstrates how Potato takes control of the lab group activities by using commands and expressing his confidence in his abilities. For reference, at this point students are holding a charged balloon (charged with static electricity from being rubbed with hair, a wig, or fake fur) above a packet of salt on a scale in order to measure the electrostatic force between the balloon and the salt packet at various heights. The commands Potato issues to Rose are related to her methods for holding the balloon above the scale and then for her approach to charging the balloon. As indicated previously, the video camera was not aimed at this group during the lab, and thus, gestural data are not present in the transcript (participants include: Rose (R), OneDirectioner (OD), and Potato (P)).

Extract 9

72	P: You zero it no yeah. Yup okay. No! [you don't touch it to the envelop ## things
73	R: [A::::::::h!
74	OD: [A::::::::h!
75	P: M-maybe hold it like this
76	OD and/or R: We tried that
	---*Deleted one line, non-group member comment*---
78	R: How much salt did you put in there?
79	P: Ah I don't know, I don't think it matters.
80	Unidentified female: No?
81	P: Like that much I mean you can't put a ton in.
82	R: It is so hard.
83	OD: Do it fast.
84	R: The hardest
85	P: Do it like all around
86	OD: Yeah
87	P: Not just like that.
88	R: I know I am but it's pretty hard.
89	P: Don't don't let it touch anything.
90	R: See.
91	P: No don't let it touch (2.0) see.

92 R: It like repels. It's repelling.
93 P: No it's floating its.
94 R: No [its repelling I'm #-ing
95 P: [It's attracting to you. Why would it it it's attracting to you.
96 R: Oh really? Unhn
97 P: Ye[ah look it's sticking to your arm.
98 OD: [Yeah
99 R: @@@@ I give up okay?
100 P: °I gots this°.
101 R: I'm negative.
102 P: Check out I have to really hold it you don't just grab it by the end. ####

This extract starts with Potato giving Rose instructions in Line 72 and then reacting with an exclamation "No!" and an explanation for why Rose's action was incorrect (she accidentally touched the balloon to the salt packet thereby discharging the charge from the balloon onto the packet). Rose and OneDirectioner also respond to the accident when it happens in Lines 73 and 74. In Lines 82, 84, and 88 Rose comments on the difficulty of her task of charging the balloon. These claims of how "hard" the task is serve to decrease her potential authority as a science expert where Potato's instruction in Lines 85, 87, 89, and 91 serve to increase his epistemic authority because they contain no hedges and are issued in the form of commands. Rose attempts to provide a justification for her trouble in holding the balloon above the salt packet in Lines 90, 92, and 94. Potato rejects Rose's explanation (Line 93) and provides an alternative explanation in Line 95, which Rose accepts in Line 96. In Line 97 Potato continues his explanation and OneDirectioner agrees with his assessment of the situation (Line 98). In Line 99 Rose gives up her task of being balloon charger and holder, and Potato willingly takes up her task in Line 100. Potato also immediately begins to provide a technical explanation for how the task should be completed (Line 102). In this extract Potato's monitoring and commenting on Rose's behavior is likely the reason she gives up on her task (Line 99). Potato has the expertise and Rose eventually defers to him completely by giving him the task after she is unable to suitably follow his instructions.

In the second part of the lab Rose again shows a lack of expertise when she asks Potato to dictate the experiment's hypothesis to her. Potato initially responds to Rose's question by asking her what she thinks the hypothesis should be. When Potato starts joking around, "you're positive? Cause you could be wrong," and then "but you're probably not wrong"; Rose responds, "Just give me the answer." In this case it initially appeared that Potato invited Rose to participate in an exchange of ideas but as the conversation developed Potato began joking around with Rose and she gave up on her own efforts and asked Potato to tell her "the answer." A few lines after this exchange Potato begins charging the balloon and Rose protests that she was "the one supposed to charge it." These moves by Rose demonstrate the way that she was complicit in co-constructing herself as a *good assistant*. They also demonstrate the importance of articulating an authoritative stance when constructing science expertise.

In addition to conversations similar to the ones described above and demonstrated in Extract 9, this group also entered into a conversation about hair that brought with it conversations about what it means to be American and who in the group was a legitimate Spanish speaker. The need to charge the balloon in the lab with something hair-like or actual hair initially opened the door to hair as a topic of conversation. Rose said that she wanted to charge the balloon on Potato's head, which he rejected as an option. This sparked a comparison of their hair in which Potato characterized Rose's hair as thick and dark, while his hair was so blonde it was hard to see, according to Rose. The conversations about hair quickly became race related and then related to language. The conversation in Extract 10 took place in the second part of class after hair had already been discussed multiple times. The students had just been discussing Rose and Potato's hair colors (Potato (P) is blonde, Rose (R) and OneDirectioner (OD) are brunettes).

Extract 10

R: I'm not into blondes I'm sorry.
P: Wow! What's wrong with us?
OD: @@@
R: You don't speak Spanish (that's what) and (you're) anti-Mexican
OD: [Oooohhhhhhhhhhhhhh=
P: [wow I speak Spanish I speak Spanish
OD:= she's only into Mexicans
R: oooooooohhhhhhh sup okay I'm into
P: My brother's in Mexico so
R: I'm into international [@@@ [you can kinda=
OD: [@
P: [Culturally significant
R: =say that with a person yeah
P: No it's culturally significant? Is that what you mean? <*balloon rubbing continues*>
R: Yeah
P: Yeah
R: Different cultures there you go. (0.5) I don't want an American.
P: M:er-i-ca
R: M:er-i-ca
OD: Wait you don't want no American?
R: No I don't know why
OD: My mom is like making me become American.
R: Why?!
OD: I don't know
P: Making you what?
R: No offense @
OD: @
P: Making you what?
<*R laughs*>
P: Speak American? (2.0) wait it's is it right?
OD: No
R: No.
P: Eeer great I think it touched. Wow that's t- point one negative point one.
OD: .hhhhhh okay.
P: I don't know what's wrong with @ either of you doing it but you're not doing it right.

Rose continues the conversation about hair color by commenting that she is not romantically interested in people with blonde hair (Line 443). When asked why by Potato (Line 444), Rose responds that blonde-haired people "don't speak Spanish" and are "anti-Mexican." Potato contests this claim by stating that he speaks Spanish (Line 448), a claim that he reiterates later on in the lab as well when another discussion about languages takes place. In Line 451 Potato continues to contest being positioned as anti-Mexican by mentioning that his brother is in Mexico. Rose continues by explaining that she's interested in "international" people (Line 452). Potato then corrects her choice of words by offering "culturally significant" in Line 454 and reiterating this claim with a stronger claim to authority in Line 456 by starting his turn at talk with "No." Rose accepts Potato's claim to authority on how to talk about diversity or internationalism in Line 458 with "yeah," but she also offers her own alternative wording in Line 460, and she reiterates her lack of interest in "American" love interests. Potato responds to Rose's statement with a pronunciation of America which invokes an unflattering (southern, uneducated) stereotype of the United States. This could be an attempt by Potato to align with Rose in disliking certain aspects of American culture. Rose mimics Potato's pronunciation of America. The conversation then shifts as OneDirectioner brings up her immigration status. Potato makes two bids to join the girls' conversation in Line 471 and 473, which the girls ignore. Potato then returns to talking about the lab in Line 473 and the girls respond to his question, "Is it right?" (Lines 474, 475). In line 476 Potato offers an explanation for why the data collection process is not working. He then criticizes Rose and OneDirectioner for not "doing it right" in Line 479.

When interpreted in the larger context, the positioning contained in Extract 10 demonstrates intersections between race, language background and ability, and the identity models for classroom success. Over time in interactions that go beyond what can be included here, Potato is characterized as having blonde hair, being "the boss," being a local science expert, being American (often used as a proxy for "White native English speaker"[14]), and speaking English. In contrast, Rose is characterized as having thick, dark hair, being Mexican, speaking Spanish, being an assistant, and not having science knowledge. This convergence of student characteristics helps to reinforce stereotypes about who can or should be a scientist (White middle-class males) and who is not a scientist (in this case, Spanish-speaking Latinas).

Overall in this lab Rose is denied opportunities to develop science expertise both by her own actions and the positioning imposed on her by Potato. As a result, Rose does not explicitly actively co-construct science content knowledge verbally with her peers. Despite the fact that Potato does not ratify Rose's attempts to demonstrate expertise, he does verbalize technical explanations for his actions and the solutions he develops for labs. Of all the students who reliably index a science expert identity in this dissertation, Potato provides the most technical explanations when compared to others. It is likely that Rose and OneDirectioner, as eager listeners, gain knowledge from Potato in the same way that they likely construct knowledge in teacher-led lectures. Thus, my analysis here should not imply that there is no level of meaningful apprenticeship in these interactions. However, I do endeavor to demonstrate the way that social dynamics impact whose expertise is validated in the classroom. What would happen if Potato did not reject Rose's ideas outright? Perhaps a more equitable negotiation of meaning could take place if some students' comments were not dismissed without more discussion. As a result, all students would have greater access to negotiating science content and language.

[14] All three focal participants refer to White native-English speaking students as American in classroom interactions and during our interviews. What is interesting here is that Rose was born in the United States.

5.1.4 Lab 3 – Rose as an Aspiring Expert

In Lab 3 students attempted to measure the speed of a wave traveling through suspended rope using accelerometers, which were taped to the rope and kept at the same distance apart. In each setup the two accelerometers were hooked to one small hand-held LabQuest (lab computer). This lab spanned two class periods, 03/09/15 and 03/10/15. During the first class period students engaged in a lecture, a prelab task, a whole class discussion about the lab, and initial phases of lab setup. The group for this lab included at first only OneDirectioner, Rose, and Gu Jun Pyo, with Captain America joining the group after the prelab exploration and before the whole class discussion on the prelab. In the first few lines of conversation between Rose, OneDirectioner and Gu Jun Pyo during the prelab task instead of participating in OneDirectioner and Gu Jun Pyo's conversation about how to measure wave speed Rose instead begins by asking, "Is Captain America here?" Captain America was often perceived to be a science expert by her peers, so it is interesting that Rose joined the conversation first by trying to locate a possible expert as opposed to talking about science content. During the girls' initial conversation it appeared that Gu Jun Pyo and Rose would both become group experts and share the top position in their local expertise hierarchy. They both provided suggestions for how to measure wave speed and they evaluated each other's comments. After the girls agreed to use one of Rose's ideas, to affix the rope to the ground, she said, "You're welcome," indicating her pleasure at having her idea accepted by her peers. However, soon after this conversation the girls asked the teacher for help and during his visit Gu Jun Pyo and the teacher crouched at the lab station on the floor while OneDirectioner, and Rose stood and watched Gu Jun Pyo and the teacher. During and after the conversation with the teacher, Gu Jun Pyo emerged as the group expert by serving as the group spokesperson with the teacher.[15] This position was further solidified during the whole class discussion when Gu Jun Pyo again served as the group's spokesperson by sharing their plan for the lab with the class.

Where does this positioning leave Rose? After the whole class discussion the girls got back into their group and Captain America, who had been absent from the prior activities, joined the group. As I will argue later in the chapter, Captain America eventually supplants Gu Jun Pyo at the top of the expertise hierarchy and Rose becomes repositioned at the bottom of the hierarchy despite attempts to construct herself as an expert. This positioning is discussed via the example in Extract 11. However, there was one nonscience conversation prior to the conversation in Extract 11 that requires attention.

Early in their work together as a team of four students, Rose brought up the topic of the newly forming school soccer team. Rose asked OneDirectioner to join the team with her, to which OneDirectioner responded that she "hates" soccer. The discussion quickly turned to the fee associated with joining the team, which was $75. Throughout the conversation OneDirectioner and Gu Jun Pyo argue that this is too expensive and in the process they criticize the school's extracurricular activities and school mascot. Over time Captain America and Rose align with each other in defending the school. This social positioning is relevant to note because it helps to show Rose's desire to positively affiliate with the school and her peers who are perceived to be "smart" students. The

---

[15] The teacher tried to engage Rose and OneDirectioner in the conversation by making eye contact with them while explaining things and by inviting them to look more closely at something on the floor. However, neither of the two girls contributed verbally or then crouched on the floor to indicate more active participation in the conversation with the teacher.

students who are often the science experts during lab tasks also often participate in extracurricular school activities. Thus, the effort to defend school activities positions Rose socially as the type of person who could be a science expert.

Although Captain America exhibits expertise early in the group's activities on Day 1 by answering technical questions posed primarily by Gu Jun Pyo, she does not come to be the clear group expert until the second day of the lab when students set up the LabQuest (i.e., lab computer) for the lab. Rose takes a leadership role when students set up the lab on Day 2 working with Captain America to set up the rope while Gu Jun Pyo was in a different part of the room. While Rose did not physically participate in the collection of data, she did provide evaluations of her peers' performances while collecting data as evidenced in Extract 11. In this extract the students are determining how best to strike the rope in order to introduce the disturbance/wave into the rope (participants include: OneDirectioner (OD), Captain America (CA), Gu Jun Pyo (GJP), and Rose (R)).

Extract 11

603 OD: What was it? <*turning to her paper on the desk then leaning down towards*
604 *CA*>
605 GJP: <*looking at Rose, Rose has the tip of the meter stick under GJP's chin*> are
606 you trying to seduce me? I'm sorry that ###. <*Rose laughs, the meter stick slips*>
607 R: [you moved it wasn't my fault you moved.
608 CA: [Um
609 GJP: You were like going slow @@ <*Rose pokes GJP again with the meter stick*>
610 CA: the change in time is point zero zero. <*GJP and OD lean closer to the*
611 *LabQuest which is in front of CA*>
612 R: Okay GJP's gonna do it I wanna see how you ####, whooo! <*OD gets out of seat*
613 *and sits on the floor with her notebook. GJP grabs her notebook*> OD can copy (off
614 of/all for) me.
615 GJP: Can you record it f-, okay can you record it for me? <*passing notebook to OD*>
616 OD: ###
617 CA: point zero zero three (°######°)
618 R: °####°
619 CA: <*inaudible comment*>
620 GJP: <*smiling at CA*> I wanna go now.
621 R: Okay yeah I wanna I needa see this.
622 GJP: @@@ okay

R: What are you doing wrong?
<*GJP strikes the rope*>
CA: How can you hit a rope wrong? That's my question.
<*Rose, GJP OD laugh. GJP leans in to see the LabQuest screen*>
GJP: These are perfect!
<*OD and Rose lean in to look at the LabQuest*>
R: How! [How! GJP you're doing something wrong. <*GJP and Rose laughing*>
OD: [o:h! Okay we all know the one who's the (best right) <*smiling then laughing, CA adjusts the way she is sitting moves closer to GJP, leans back against teacher's desk*>
GJP: No! No! one more time, give me one more chance.
CA: Should we do it again?
<*GJP strikes the rope*>
GJP: I won't hit it wrong, (it's impossible). <*CA smiles and laughs, Rose & OD also smiling*>
CA: Okay [that was fine.
R: [Okay that was, okay. <*smiling*>
GJP: Yes::::: <*snaps fingers and moves hand left and right*> ah that hurts.

This extract shows Rose participating in off-task behavior, something that occurred more frequently as the lab progressed (Lines 605-607), but it also demonstrates her attempts to evaluate Gu Jun Pyo's performance and to align herself with Captain American in these evaluations. In Line 612 Rose indicates that she thinks Gu Jun Pyo is incapable of striking the rope correctly. Rose also makes a comment to OneDirectioner about her copying for or from Rose (Lines 613-614), which positions OneDirectioner as her assistant. Rose continues her evaluation of Gu Jun Pyo's incompetence with her comment in Line 612 and her question in Line 623 which directly frames Gu Jun Pyo as "doing [it] wrong." Rose's exclamations in Line 629 are a response to what she perceives as poor data on the LabQuest resulting from Gu Jun Pyo striking the rope. In her next turn at talk Rose positively evaluates Gu Jun Pyo's second attempt to properly strike the rope after Captain America has evaluated Gu Jun Pyo's performance as acceptable in Line 638. These evaluations of Gu Jun Pyo's performance show Rose's attempts to be seen as a science expert by her peers. However, her lack of more concrete participation in the data collection process and the fact that her comments follow comments about accuracy made by Captain America as opposed to being her own independent evaluations indicates that

Rose will not be perceived as an expert by her peers. Rose does participate in calculations at the end of the lab and at one point she provides OneDirectioner with instruction on what to do with the numbers the students collected.

Rose's participation in Lab 3 demonstrates the social nature of expertise. At one point Rose comments on the "inconsistency" of the data that they have collected and Captain America disagrees with Rose about data quality, but she positively evaluates Rose's comment about "consistency" in data collection. I interpret that conversation as another example of Rose attempting to play the part of science expert despite not necessarily knowing the science content or using science vocabulary accurately.

5.1.5 Summary of Rose's Pathway of Social Identification and Learning

Extract 8 demonstrated Rose's attempts to participate in discussions of science content with Potato and Satan. Rose was excluded from the conversation and thus prevented from negotiating science language and content with her more expert peers. Potato's refusal to slow down his speech on multiple occasions, and his dismissal of Rose's attempts to contribute to the design of the experiment (12/10/14, 12/11/14 Mapping Notes) served to deny her expertise. Rose's social positioning as an assistant prevented her from participating in discussions of science content and thus prevented her from having the opportunity to verbally construct scientific understandings during Labs 1 and 2. Despite my observations and analysis of Rose's social positioning in Lab 1 as negative, Rose indicated that she enjoyed working in this lab group. I believe that this is because when asked, Potato did provide many technical explanations to his peers. Although Rose was often denied access to scientific knowledge during decision-making, the frequency and detail in Potato's technical explanations at other points in the lab likely gave Rose access to the scientific information being represented, modeled, or negotiated in the lab. If it is possible to learn the science while serving as an assistant, why should we worry about this type of social positioning? Rose was not an academically successful student in the physics class from the standpoint of grades. She reported in 2016 that she did not earn a good grade in the physics class. So, despite reporting feelings of understanding as a result of participating in labs with Potato and Satan, Rose may not have understood as much as she thought she understood when answering interview questions. Rose's verbal participation across all labs demonstrated a desire to discuss science content with her peers and a desire to articulate the social role of the science expert. In denying her this role, Rose's peers restricted her access to learning science content and language. Figure 5.1 provides a depiction of Rose's pathway.

5.2 OneDirectioner

5.2.1 Interviews

OneDirectioner is a 14-year-old who was born in the Dominican Republic. At the time of the study she had lived in the United States for 2 or 3 years, and she was in her 1st year of attendance at SFAA. OneDirectioner did not start learning English until she moved to the United States. She had previously attended a different public charter school in the same city. Her mother learned about SFAA through a friend whose son also attended the school, and OneDirectioner had a younger brother who was also attending the school. OneDirectioner was labeled as an English Language Learner by the school at the time of the study but she tested out of the ESL program the following year. However, OneDirectioner chose to continue participating in the English Language Development (ELD) class in addition to participating in mainstream 10^{th}-grade Language Arts. Early in her ninth-grade school year OneDirectioner could be found writing scripts to prepare for talking to her teachers or to prepare for sharing out in class. By the end of the school year OneDirectioner reported that she had given up this practice "a while ago."

As mentioned in Chapter 3, OneDirectioner and Gu Jun Pyo participated in four interviews together (two in January and two in February) and they each participated in one individual interview at the end of the school year (May). The following subsections address OneDirectioner's feelings about science, her physics class, and her previous experiences with science instruction (Section 5.2.1.1), and her perspectives on speaking English and Spanish at home and in school and the tensions that she experienced related to these language practices (Section 5.2.1.2).

5.2.1.1 Science Classes and Learning Science

In January OneDirectioner reported liking her physics and history classes but hating math. Her dislike of math came up in multiple interviews. One of the things OneDirectioner did not like about physics was, "I like science but I don't like the math and science" (02/10/15). OneDirectioner reported that she had not taken any science classes in her previous school in the United States.[16] As mentioned in Chapter 4, OneDirectioner did not consider herself a science person but she did want to go to medical school, a career path she mentioned in two different interviews.

In her May interview OneDirectioner reported six qualities as being important for

[16] Her previous school was a public charter school that used an integrated curriculum. Despite feeling like English and history classes were integrated, OneDirectioner felt that her math classes did not contain any science.

being a good science student during the card sort activity described in Chapter 3: explaining your thinking, working well with others, participating in class discussions, using scientific vocabulary in writing, solving problems, and analyzing data. Four of these behaviors of being a good science student related to group work when described by OneDirectioner. OneDirectioner indicated that she explains her thinking when taking notes in her notebook but also “when we’re like talking in groups you’re explaining your thinking a lot.” OneDirectioner also commented that “you need to have good communication and if others need help you help them if you have questions you ask.” These values partially overlap with characteristics of the *good student* model described in Chapter 4.

OneDirectioner also mentioned group work when she discussed solving problems when “something goes wrong you try like to solve it with other with other people in your group.” This focus on collaborative skills as part of what it means to be a good science student in this physics class was also present in Rose’s responses. In the many days and weeks that I spent in the classroom, I never once heard the teacher provide direct instruction to the class on how students should collaborate with each other during labs or other group assignments. Thus, these comments on how to work well in a group are likely not revoicings of the teacher’s instruction. Given that students in this class spent a large portion of time working in groups, it is not surprising that their descriptions of being a good student in this class included comments related to collaboration.

Like Rose, OneDirectioner did not find it necessary to use scientific vocabulary verbally in conversations in her science class. She described talking like a scientist as, “saying big words, like people don’t know those words. I don’t think it’s really important. It's important to know them but not like really important." Despite indicating that students should know and be able to write these words, OneDirectioner did not think it was necessary to use these terms verbally in order to be considered a good science student in her physics class. Interestingly, OneDirectioner indicated that using science terms in conversation would be a characteristic of her ideal science classroom community. When I asked her why, OneDirectioner said, "In a perfect class everyone talks that way." OneDirectioner also indicated that in her ideal science class she would collect good data and students would volunteer answers in class. When asked to elaborate on the latter of these practices OneDirectioner said, "It would be better for me, like speaking more, like everyone participating. It's like perfect no one like no one is afraid." When asked why she does not participate more in class discussions in her physics class OneDirectioner responded, "I'm not good; I'm not really good with physics so that's why." In other interviews OneDirectioner indicated additional reasons, related to fear of judgment from peers and the teacher, and her English ability as reasons for not speaking in whole class settings. Overall OneDirectioner's comments reflect an interest in science and a conception of being a good science student that overlaps in part with the description of the *good student* model outlined in Chapter 4.

5.2.1.2 Speaking Spanish and English at Home and in School

In addition to discussing her experiences and perspectives on learning science, OneDirectioner also discussed her experiences speaking Spanish at home and in school. Tensions in OneDirectioner's feelings about being a Spanish speaker in an English medium school were apparent in each of the first four interviews. In Interview 1, OneDirectioner claimed that she didn't like attending SFAA because "everybody knows each other, and I'm like the new one." Gu Jun Pyo and OneDirectioner offered the following perspectives when asked about cliques in the school:

> Gu Jun Pyo: I've seen some people sit alone at like the lunch tables so me and OneDirectioner usually sit with them and talk to them. But like its its ironic how this school be its like ironic how at this school you're supposed to be nice and kind and everything (Sarah: right, right) but there are still some people outcasted because they they don't fit your little cliques standards, and like
> Sarah: And has that been part of why you feel it's difficult here?
> OneDirectioner: Yeah because like in other schools like [name of local public school] there's like more Spanish people like they're talking in Spanish and things and I didn't want to come to this school cause like everybody had ### (Sarah: yeah) and it's like really hard for me cause like everyday is like more hard for me (Sarah: yeah) like doing things.

The theme of being an outcast emerges in many of the interviews with OneDirectioner and Gu Jun Pyo. In this excerpt OneDirectioner implies that she would rather attend a school with a larger percentage of Spanish speakers. OneDirectioner continues by explaining that she feels that students at SFAA don't want to talk to her because she doesn't speak English well.[17]

> Sarah: Like if you feel like because you speak Spanish I don't know that you're treated differently here or that its like
> Gu Jun Pyo: Usually the Spanish people mix and the (OneDirectioner: yeah) English like the American people mix and then when they do when sometimes they do mix sometimes its not like (Sarah: a positive thing?) something you see usually and its weird.
> OneDirectioner: Like I think some people know I don't talk like really good Spanish and they're like, they like get away from me like they avoid talking to me or something.
> Sarah: Wait because of the way you speak Spanish?
> OneDirectioner: Yeah I think I feel like that I don't know.
> Sarah: *Porque eres de Republica Dominicana*? [Because you are from the Dominican Republic?] Okay so your Spanish is different. Are most of the students here *de Mexico* [from Mexico]? Or like
> Gu Jun Pyo: Yeah like they're really mean like with OneDirectioner I used to be

[17] It is prudent to note that there is a miscommunication in the excerpt below. When OneDirectioner mentions not speaking Spanish well, I believe she intended to say English based on the way the conversation progressed.

> in a group and like I saw how you want to say that? Like they never like they just exclude you (OneDirectioner: yeah). (Sarah: oh my gosh) Like if you don't speak good English they like oh so they go like, they turn away from you like I saw OneDirectioner was sitting there and then they just turned away from her they just excluded her from the conversation then you're like…..
> Sarah: Wait this was other students who speak Spanish too?
> Gu Jun Pyo: No,
> Sarah: Oh just like (OneDirectioner: yeah) other like English-speaking students.
> Gu Jun Pyo: But like sometimes Spanish is viewed like its viewed as something bad if you talk in front of someone Spanish if they don't understand it but sometimes it's the only language you can talk (Sarah: yeah) and your trying to your trying to like make the person comfortable. (01/27/15)

This conversation demonstrates that OneDirectioner and Gu Jun Pyo felt excluded from social groups because they spoke Spanish. In OneDirectioner's case she appears to feel that this is also because of her (perceived) lack of English-speaking abilities. Both OneDirectioner and Gu Jun Pyo described feelings of being marginalized by teachers and students as a result of being Spanish-speaking Latinas. OneDirectioner and Gu Jun Pyo also discussed the lack of knowledge among students and teachers in the school about the varieties of Spanish in the Spanish-speaking world. OneDirectioner stated, "There's like a stereotype here in [state name] that if you speak Spanish like people think you're Mexican." OneDirectioner and Gu Jun Pyo continued by talking about different accents and different vocabulary (e.g., the socially appropriate uses of *mande*) in varieties of Spanish.

OneDirectioner also mentioned feeling uncomfortable in classes as a result of her English abilities, "I don't like talking in front of the class cause I always say something wrong in English" (01/27/15). OneDirectioner stated, "I don't understand something and like I keep quiet because like you know sometimes in English its like hard." OneDirectioner mentioned that she didn't like asking the teacher questions one on one because even the act of having to get up from her desk and have her peers see her go to ask him a question made her feel, “You’re stupid because you don’t get it.” When describing the school OneDirectioner made the following comment:

> OneDirectioner: This school has a reputation like everyone like everyone in this school is super smart and like at first I didn’t want to come here cause like everyone is like that and like I feel like in class I shouldn’t like I don’t like comparing my answers I don’t like people looking at my test or something cause there’s always like that type of thing like oh you are not smart cause you have this wrong or oh like I feel like that pressure on me like every time.
> Sarah: All the time
> OneDirectioner: So I don’t like the teachers
> ---*Deleted lines*---
> OneDirectioner: yeah like I feel like in this school people really judge you a lot cause of they’re smart. (01/29/15)

This exchange exemplifies the feelings of judgment repeatedly indicated by both Gu Jun Pyo and OneDirectioner when discussing their interactions with peers and teachers. At one point I asked OneDirectioner if she would feel more comfortable in class if more of her teachers were Latino/a to which she responded, “I think it would be yeah, I think um bilingual is very important” (01/29/2015). Language background and being an L1 Spanish speaker seem to factor into OneDirectioner’s feelings of marginalization at SFAA.

In February the teacher put students into new table groups (students stay in these groups for months) and OneDirectioner and Gu Jun Pyo both discussed dissatisfaction in their new assigned seats. OneDirectioner mentioned, “So I just need sometimes I need help with translating things in English so I will tell him to sit next to Rose” (02/10/15). In this scenario the teacher likely did not know that OneDirectioner felt she needed to speak Spanish in class in order to support her learning in and of English. In discussing reactions to her use of Spanish in school OneDirectioner reports, “Like when we talk in Spanish some people are like, ‘what are you saying about me, like you’re saying something bad about me.' Then one time I was walking I think I was talking with Gu Jun Pyo and like in Spanish like I was talking really fast and people look at me weird cause I was talking in Spanish" (02/17/15). When I asked Gu Jun Pyo and OneDirectioner to draw a map of the student cliques in the school they noted places where cool kids, couples, sports boys, and smart kids hang out and they indicated that Latino/a students are not in the cool kid and smart kid groups. When I asked where the Latino/a students spend nonclass time they indicated that they walk all around the building but do not have a specific hangout area.

These comments from OneDirectioner demonstrate that she does not feel completely comfortable in the SFAA community and that her discomforts stem largely from the values explicitly and implicitly placed on speaking Spanish both inside and outside of classes. OneDirectioner reports feeling judged for speaking Spanish outside of class, and she indicates that this feeling of judgment also impacts her willingness speak up in class. OneDirectioner also indicated explicitly and implicitly that some of her teachers do not seem to be aware of her language needs. These statements about how OneDirectioner feels about the SFAA and science classroom contexts help to contextualize the description of her participation in science labs in the following sections.

5.2.2 Lab 1 – OneDirectioner as a Good Assistant

As described in Chapter 4 and prior sections of this Chapter, OneDirectioner participated in Lab 1 with Rose, Potato, and Satan. In this lab the expertise hierarchy was: Potato → Satan → Rose → OneDirectioner. For this analysis I refer to the extracts already provided for this lab (Extracts 7 and 8). Over the course of the lab, OneDirectioner was continually positioned as a good assistant at the bottom of the hierarchy. This positioning occurred despite side conversations with Rose in which OneDirectioner actively agreed and disagreed in English with Rose's approaches to completing the tasks given to Rose by Satan and Potato. In Extract 7 we saw OneDirectioner participate as a good assistant by retrieving materials (e.g., *scissors* in Lines 36 and 39, and a *ruler* in Line 65) for her peers. While OneDirectioner did not retrieve materials for the group in Extract 8, her only verbal contribution to the conversation was to mention to Rose first in Spanish (Lines 20, 22, 24), and then to the group in English (Line 37) that she did not understand Potato when she first met him. As I argued above, OneDirectioner's use of Spanish and the alignment between Rose and OneDirectioner as both Spanish-speakers and people who don't understand Potato served to position Rose and OneDirectioner as nonexperts. This was in part due to the way that Satan and Potato responded to OneDirectioner's use of Spanish during the lab.

In addition to the participation outlined in Extracts 7 and 8 OneDirectioner expressed concern for her lack of skills when compared to the other students in multiple ways during lab 1. In one particularly poignant moment, OneDirectioner had the opportunity to reposition herself within the group when Rose invited her to complete a round of data collection. OneDirectioner refused to complete the task stating, "You guys are the smart ones" (12/03/14). Taken together, OneDirectioner's verbal and nonverbal acts during Lab 1 served to consistently position her as a *good assistant*. As such, she had little access to verbally negotiating science content or using technical language.

5.2.3 Lab 2 – OneDirectioner as an Aspiring Good Student

In Lab 2, OneDirectioner participated verbally in lab conversations much more than she did in Lab 1. In this lab OneDirectioner worked with Rose and Potato to measure changes in the electrostatic force between a charged balloon and a packet of salt as a function of distance. OneDirectioner's increased verbal participation could be the result of her becoming more comfortable in the classroom environment. At the time of this lab she had worked with this particular group of students, who she sat with at the same table, for many months. OneDirectioner was likely also gaining proficiency and confidence in speaking English with her peers.[18]

OneDirectioner participated in Lab 2 as a *good student* and as a *good assistant* when she made verbal and physical contributions. However, she was often an observer as Rose and Potato manipulated materials and dominated and controlled conversation. As a language learner, a new student in the school, and relatively new immigrant in the United States, it would be appropriate for OneDirectioner to spend time observing her peers. What is relevant to view then, when understanding OneDirectioner's pathway of socialization rather than her quantity of participation, is the way that her actions were taken up, ignored, or rejected by her peers when she did choose to participate verbally in conversations.

At the beginning of the lab OneDirectioner asked Rose, "So, how are we going to do it?" This question indexes a good student identity by demonstrating that OneDirectioner cared about how the lab task would be completed. Her question also demonstrated a bid to start the lab. In the subsequent interaction Rose manipulated the

---

[18] OneDirectioner explicitly referenced changes in her English abilities in Lab 1, Extract 8 when she mentioned that she could not understand Potato when she first met him (Lines 22, 24, 26).

balloon and tested the lab materials while OneDirectioner offered suggestions for what to do. When Potato returned to the group, OneDirectioner participated mainly through one-word utterances of agreement. At a few points OneDirectioner issued commands to Rose for example, “Do it fast” (Line 83, Extract 9) and a few lines later “Put it lower” (not in Extract 9), to which Rose replied, “Yeah, I now.” Though at first these commands may appear insignificant because they were not as frequent as the commands given by Potato and Rose, this willingness to give a peer a command demonstrates a change in how OneDirectioner participated in Lab 2 as compared to Lab 1. These small commands served as claims to epistemic authority. While the imperative “Put it lower” doesn’t sound scientific, the height of the balloon was the independent variable under investigation in this lab; thus, OneDirectioner’s commands demonstrate her participation in the collection of accurate data and the construction of science knowledge. These commands were well received by Rose who attempted to do as OneDirectioner instructed her in these instances.

A few lines after the commands described above, OneDirectioner provided a suggestion for how the group should measure the distance between the balloon and the salt packet, “We can maybe use a ruler.” Potato immediately responded by dismissing the suggestion, “Yeah, it’s rounded, so we can't like see it.” OneDirectioner’s immediate subsequent comments after this rejected suggestion were primarily one-word utterances of agreement with Potato (e.g., Lines 83 and 98 in Extract 9). This was the only verbal suggestion OneDirectioner provided during the phase of the lab where students were constructing their setups. OneDirectioner’s agreements with Potato index a *good student* identity and the absence of additional suggestions and negotiation of meaning with Potato and Rose indicate that OneDirectioner was not performing the role of *science expert* in this group.

In a subsequent conversation, OneDirectioner interrupted Rose's off-task behavior by saying, "Alright, I'm taking the data; you convert it." Though Rose ignored OneDirectioner's nomination for the task of recording data and making calculations, this act by OneDirectioner served to again index a *good student* identity by signaling her attention to task completion. At one point when OneDirectioner was engaged in physically collecting data, Potato issued a series of commands to her. After Potato commented, "No! It needs to be perfect," OneDirectioner asked Rose to complete her task. OneDirectioner then participated in giving Rose instructions, with Potato, when Rose took over the balloon-lowering task. In Lab 2 OneDirectioner participated primarily by agreeing with the expert, by asking technical questions about the lab report, by issuing some commands to Rose, and by listening to her peers. These behaviors collectively signal a *good student* identity

Of the seven commands given by OneDirectioner to her peers in the first 25 minutes of the lab, three were rejected by Rose, and the other four were accepted without comment as OneDirectioner gave instructions. This means that more than half of her commands were positively received whereas only 18% of Rose's commands were well received by Potato and OneDirectioner. It seems possible that OneDirectioner entered into fewer commands in part because she was hesitant to participate more generally. Overall, OneDirectioner was able to articulate a *good student* identity in this lab interaction. However, her relative silence and lack of verbal participation in some cases may reflect lost opportunities for her to learn language and content. OneDirectioner's silence could derive from her personality or a lack of confidence as opposed to overt negative social positioning by her peers. However, in watching the interactions between Potato and Rose, it is also possible that OneDirectioner saw a model of what it looks like to engage in attempts to negotiate meaning with Potato and she subsequently chose not to subject herself to this type of interaction.

It is also important to consider OneDirectioner's participation in the context of her comments in interviews. If OneDirectioner was consistently self-conscious about her English abilities and how she would be perceived as a Latina in her lab group, then this might cause her to remain silent as opposed to risking judgment from her peers by participating verbally in peer group discussions. It is unlikely that the multiple conversations related to language ability in this group made her more comfortable in her identity as a non-native English speaker. Although OneDirectioner participated minimally in the hair conversations between Potato and Rose, she and Rose had a separate conversation about her curly hair and her comment about her mother wanting her to become American. Extract 10, Line 465 demonstrates her social affiliation with Rose not Potato.

5.2.4 Lab 3 – OneDirectioner as a Good Student

In Lab 3, measuring the speed of a wave, OneDirectioner worked with Rose, Gu Jun Pyo, and Captain America. OneDirectioner participated in Lab 3 as a *good student.* She asked questions of her peers, made moves to keep the group on task, and participated physically in the lab setup and data collection processes. However, OneDirectioner was prevented from developing expertise in her lab group in two ways. First, she did not have the background knowledge necessary to operate the LabQuest which denied her the role of data evaluator and resident *science expert*, and second, Gu Jun Pyo actively worked against allowing OneDirectioner to be positioned as more capable than her. I discuss each of these reasons in the paragraphs below.

Early in the lab OneDirectioner held the LabQuest but she did not know how to change the sampling rate in the program students were using. OneDirectioner made at least four attempts to ask a peer for the information she needed. Only Captain America knew how to make the necessary changes to the LabQuest to set it up for the lab. Rather than explaining to OneDirectioner how to make the necessary change, or showing her while looking at the LabQuest together, Captain America took the LabQuest from OneDirectioner in order to make the change and she did not return it to her afterwards. As a result of not knowing how to change the settings on the LabQuest, OneDirectioner was moved out of a position (data collector) that would have increased her exposure to the science content of the lab, provided her with additional lab skills, and enabled her to use technical language. The fact that Captain America was the only student who knew how to use the LabQuest denied the other students access to a deeper understanding of the lab content and denied them access to a social role of leading the data collection process.

In Extract 11, Line 603 OneDirectioner asks for someone to read out the last data point, and Captain America responds in Line 610 by starting to read a value. The other girls lean in to also look at the LabQuest and the group then continues attempting to collect additional data points. They are thwarted in this endeavor by Gu Jun Pyo’s rope strikes that cause uninterruptable data. OneDirectioner does not say very much in Extract

11. However, she does positively evaluate her own skills as a rope striker in Line 630. Prior to this, in Lines 612-613 and Line 615 Gu Jun Pyo and Rose attempt to position OneDirectioner as their assistant by asking her to copy data for them. Although OneDirectioner appears to take up the role of data recorder, she does not verbally respond to the requests and she continues participating in the larger conversation about striking the rope.

As the interaction continued after Extract 11, Captain America continually tried to prevent Gu Jun Pyo and reposition OneDirectioner as the person to strike the rope. Captain America's attempts included comments such as, "If your data is really similar to OneDirectioner's then it's fine." As Gu Jun Pyo's rope strikes continued to lead to uninterpretable data Captain America said, "she [OneDirectioner] has to continue doing it." This comment by Captain America lead Gu Jun Pyo to say, "OneDirectioner, you wanna defy me? I challenge you." To which OneDirectioner replied, "I'm sorry Gu Jun Pyo." The students laughed and smiled during this exchange. However, it is clear that Gu Jun Pyo was not happy to have OneDirectioner demonstrate a skill that she herself was struggling to accomplish. The validation from Captain America and the criticism from Gu Jun Pyo put OneDirectioner in a delicate position. Ultimately, OneDirectioner continued to be the rope striker for the group. Gu Jun Pyo became increasingly playful and regularly interrupted the groups' work by slapping the rope at inappropriate times requiring the group to recollect data points. These interactions demonstrate that developing expertise can come at social costs. As OneDirectioner became more capable of participating independently in the lab, Gu Jun Pyo worked against this positioning to try to maintain her own role as second in command. Overall, OneDirectioner was able to articulate a good student role in this lab. However, her lack of background knowledge on how to use the LabQuest and Gu Jun Pyo's continual challenges to OneDirectioner's skills served to prevent OneDirectioner from developing additional expertise both socially and in the construction of scientific understandings.

5.2.5 Summary of OneDirectioner's Pathway of Social Identification and Learning

OneDirectioner's pathway of participation shows her transitioning from a good assistant in Lab 1 to a good student in Labs 2 and 3 (depicted in Figure 5.2). However, OneDirectioner's silence in Lab 2, her lack of knowledge of how to use the LabQuest, and her positioning as less capable than Rose and Gu Jun Pyo through their attempts to keep her in a good assistant role worked against OneDirectioner's ability to develop and signify expertise in science content knowledge and scientific and technical language. OneDirectioner's pathway again demonstrates the social negotiations that impact, frame, and interweave themselves with academic learning.

5.3 Gu Jun Pyo

5.3.1 Interviews

Gu Jun Pyo is a 14-year-old bilingual Latina who was born in Peru and immigrated to the United States when she was in elementary school. She moved back to Peru for a short time during elementary school before her family decided to make their move to the United States permanent. With the exception of one maternal aunt, Gu Jun Pyo's extended family still lived in Peru at the time of this study. Gu Jun Pyo's mother learned about SFAA through middle school teachers who recommended SFAA to her. Gu Jun Pyo's older sister had recently graduated from SFAA at the time of the study and was enrolled in university courses in the area. Gu Jun Pyo herself was also enrolled in a graphic design course at the local community college.

Throughout the five interviews and countless conversations I had with Gu Jun Pyo during the study, she was outspoken in her dissatisfaction with the environment at SFAA, and she did not return to the school for her 10th-grade year. Many of Gu Jun Pyo's concerns came from being made to feel like an outcast by teachers and students. Gu Jun Pyo told multiple stories about interactions with staff and students in which she felt cast aside and marginalized (e.g., being "thrown out" of the building after school). This feeling of being an outcast impacted Gu Jun Pyo's interest in pursuing academic endeavors, such as honors, as described in the exchange below.

> Sarah: I'm just wondering so like sometimes it's possible to feel like physically okay no one is gonna attack me but like emotionally I don't feel like I can be myself or be safe that way. Does that make sense?
> Gu Jun Pyo: Like in honors. I wanna I didn't wanna be part of honors anymore from uh history. Because like the first time I went to the honors meeting uh there were like these groups like the groups of people who hang out with each other like the smart people were there but I'm not part of their little clique or group or whatever and like I felt left out but I just like kept with it cuz it was going good and I liked the idea project and how it worked but like you feel like when I was there in the meeting and I was just sitting alone eating my snack while everyone was talking around me I'm like okay I don't really enjoy this and like as the term progressed and progressed and progressed I just felt more like like # like don't get close to me and stuff but they were like they're still very like welcoming and kind
> Sarah: like friendly
> Gu Jun Pyo: yet they're not really like I'll be I'll be I'll be kind of nice to you but I won't actually like talk to you
> Sarah: Right like at a distance
> Gu Jun Pyo: Yeah and I felt that and if you're gonna be part of something like honors then it requires you to interact and actually feel like comfortable but I don't feel comfortable which is why I wanna drop it but
> Sarah: *Hay unos estudiantes en honors que hablan español o no?* [Are there any students in honors who speak Spanish or no?]

Gu Jun Pyo: No.

In this interview segment Gu Jun Pyo discusses feeling uncomfortable in history honors meetings. Later in the year Gu Jun Pyo tried to quit honors but stayed in the program after talking with the teacher independently, and subsequently meeting with the teacher again with OneDirectioner, who joined the history honors program in that meeting. It is significant that the absence of other Latino/a students in the honors program impacted Gu Jun Pyo's interest in staying in the program. The following subsections elaborate on Gu Jun Pyo's feelings of dissatisfaction with the school and her physics class (Section 5.3.1.1), and her perpetual feeling of being judged as a result of being Latina and speaking Spanish (Section 5.3.1.2).

5.3.1.1 Science Classes and Learning Science

Despite earning 100% on all tests in her physics class, Gu Jun Pyo reported being confused often. Gu Jun Pyo frequently articulated frustrations related to the teacher's instruction in our interviews. In her first interview Gu Jun Pyo described difficulty in knowing what to do for a lab, "It's like he's standing up; he gives vague instructions and like okay, I'll follow this picture or these instructions, but then when you actually do the lab you like get lost" (01/27/15). In other interviews she also discussed frustration at not understanding the teacher, whom she described as very "complex." Across the interviews Gu Jun Pyo provided suggestions for how the teacher could improve his instruction by being more available to students during group and independent work. From my observations, it was not uncommon for the teacher to remain at his desk for large stretches of time while students worked independently or in groups.

In the context of asking Gu Jun Pyo about aspects of the physics course that were easy for her she described enjoying working with partners such as OneDirectioner on various tasks. She also indicated that "setting up the experiment is too hard. It's not hard, but I just don't understand" (02/17/15). OneDirectioner and Gu Jun Pyo both expressed this sentiment in an earlier interview. Though I asked the girls about lab reports, they both answered the question by talking about the lab process and difficulty knowing how to set up labs:

> Sarah: Okay so just thinking about the actual process of like writing up these lab reports while you're doing the lab and keeping track of your data and all that stuff so what's easy and what's difficult what's the easiest thing about the lab reports and what's the most difficult thing about the lab reports?
> OneDirectioner: I think the difficult thing is setting it up. And like in your mind like knowing what is it going to be how its gonna work like I think that's hard.
> Gu Jun Pyo: Like remember the balloon experiment in which we had to put a weigh machine or something like we had to # with a string
> Sarah: With the salt?
> Gu Jun Pyo: With the salt I think
> Sarah: and then you did it with a probe too right?
> Gu Jun Pyo: Yeah and I didn't know how to set it up and my group was last and when we finally did set it up we were recording some data but that data turns out to not be the correct data so we're like what are we doing wrong? And he comes to help us and he's like and he can't find like an answer to our question so he's just like just write a report and say that just write your mistakes and I'm like but I wanted to understand what the report was saying so just like as OneDirectioner was saying the set up. (02/10/15)

This exchange demonstrates the continual frustration that Gu Jun Pyo experienced in not knowing how to complete lab-related tasks despite being one of the highest achievers in the class on formal assessments such as tests. Tests were the only assignments on which students received specific individualized feedback on their work.

Performing well on tests and earning good grades was important to Gu Jun Pyo, and she frequently discussed her family's expectations that she earn good grades. The excerpt below demonstrates this good student aspect of Gu Jun Pyo's identity in school at large not just in the science classroom.[19] Gu Jun Pyo also describes the importance of understanding material in addition to earning good grades.

> Well if you like I uh my parents are like um cuz I don't do anything basically, I just go to school and then just go home and do stuff so they expect me to get As and I expect myself to get As as well so if I like if I don't understand the topic yet I get an A I feel like it's just a grade so I want to be able to get a grade A but yet still understand because in the future I'm going to be applying to scholarships and all that stuff so cuz if I don't understand it now and I get like a B+ or a C maybe then maybe I'll love it in the future or something but it's gonna affect my chances of getting accepted into some colleges that I want or I don't know. (02/10/15)

This quote demonstrates the importance Gu Jun Pyo and her family place on academics and Gu Jun Pyo's interest in actually understanding the science material because it could impact her future academic career. Gu Jun Pyo demonstrated maturity beyond many ninth graders when discussing her academic and career goals. When I asked Gu Jun Pyo if she considered herself a science person she replied:

> Mm @ I sometimes like science. I enjoy it when I like know like I need a teacher to actually talk me through it sometimes but like when I don't understand I get frustrated but I think it's an okay topic for me I'm not completely lost but not completely I don't completely understand but I'm not completely lost either. Uh I'm gonna go into a field like engineering sort of so I need some math background and maybe some physics so I think I'm okay with that. Um I just the thing that gets me scared is if I don't understand this now how am I gonna understand it in the future when I get my career and stuff. (2/10/15)

In addition to demonstrating Gu Jun Pyo's positive orientation to science, this quote also demonstrates a high level of understanding of what success in the field of engineering might involve in relationship to physics and mathematics. In my experience it is common for high school students at all grades to have little knowledge of the various courses in science and math that are required to pursue Science Technology Engineering and Math (STEM) careers. Gu Jun Pyo has a good understanding of the types of courses she will

---

[19] In referring to a "good student" identity here I am invoking Lemke's (2000) notion of timescales and identities that extend beyond the walls of the physics classroom to larger school level and societal notions of what it means to be a good student.

need to master in order to pursue a career in engineering. Taken together the quotes shared above demonstrate that Gu Jun Pyo is a diligent student who likes science, but who has not had a positive experience socially or with teachers at SFAA, at least in the months preceding these interviews.

In her final interview Gu Jun Pyo selected the following characteristics as important for being a good science student in her physics class: write well, use scientific vocabulary in writing, writing like a scientist, using scientific vocabulary when speaking, speaking like a scientist, thinking like a scientist, analyzing data, and working well with others. Gu Jun Pyo selected using scientific vocabulary when writing, using scientific vocabulary when speaking, and explaining your thinking as the top three most important behaviors related to being a good science student. It is interesting to note the central role that Gu Jun Pyo placed on using science vocabulary for being perceived as a good science student. This is unsurprising given that Gu Jun Pyo's notion of being a good student, while heavily rooted in grades, is also influenced by how she compares herself to the *science expert* model. The smart student clique that Gu Jun Pyo often refers to contains students who are consistently identified as occupying *science expert* roles during lab work.

Although Gu Jun Pyo provided detailed descriptions of all of the practices she identified as important, the conversation we had about explaining your thinking and thinking like a scientist reveals intersections between Gu Jun Pyo's identity as a Latina and her identities as a good student and possible science expert. Gu Jun Pyo's comments also demonstrate her awareness of the difference between having knowledge and being able to signify that knowledge in social interaction. Gu Jun Pyo stated, "You have to think before just actually phrase it to uh display where a t- like you can understand it, but it also makes like it lifts you higher or something, it just makes you like look good." This comment from Gu Jun Pyo demonstrates that she thinks about how she will be perceived by others when she is planning her speech. This is something she also mentioned explicitly in her final interview. As the conversation continued Gu Jun Pyo clarified additional aspects of speaking like a scientist in response to a question I asked her about the end of year research project she was working on at the time of the interview. She also brought up racial stereotypes in the context of talking about being recognized as a scientist.

> @@ I don't know. So with that we cuz there's always those stereotypes that people have. Oh Americans are smarter oh Latinos are dumb or all those or vice versa depending on who you are (Sarah: yeah yeah or who you're talking to) yeah or who you're talking to cuz it might be backwards you don't know (Sarah: yeah). Or like those stereotypes of like oh Korean people they're so smart they go to school from 8 to 9 pm (Sarah: right right right) so um all those stereotypes influence um how you how you're perceived as a person (Sarah: mhm mhm) and your achievements.

This quote demonstrates Gu Jun Pyo's feeling that racial stereotypes influence one's ability to perform a scientist identity. When I asked Gu Jun Pyo if she thinks it's harder for her to be perceived as a scientist because she is Latina, she replied with a long response and a story about being chastised by peers in Physical Education class for not doing what she was told to do by popular kids. Gu Jun Pyo described how she was portrayed as incapable by her peers, "They can't help it; there's always going to be those weaklings out there, and I'm like (mm) it's not because we choose to be it's because uh they you guys don't let us do anything." I interpreted the "us" in this quote to be Latino/as based on the context of the conversation. Gu Jun Pyo brought the conversation back to academics by saying, "I like to prove myself through academics more (mhm) so when I get there I'm gonna like I'm gonna prove them wrong." These quotes demonstrate that Gu Jun Pyo feels judged by her peers both in science class and in other school contexts in part due to language and race related stereotypes.

5.3.1.2 Speaking Spanish and English in School and at Home

The comments in the previous section begin to show how Gu Jun Pyo's identity as a Latina intersects with her school-based identities. In our first interview Gu Jun Pyo offered the following response when asked about her participation in class discussions.

> Gu Jun Pyo: but like the expectancy like when there's like the teacher like in this class for example (Sarah: uhn) he explains something and you don't understand it (Sarah: yeah) and I'm like, I want to ask questions but like sometimes because you're like Hispanic or something when you ask questions your like you appear dumb for some reason and then they're like they're slowing us down (OneDirectioner: yeah) we could we know this already why why are we stopping?
> Sarah: You f- so has anybody ever said that to you? Another student said that to you or you just feel like that's what they are thinking.
> Gu Jun Pyo: It it just feels (OneDirectioner: yeah) like it. (01/27/15)

This exchange demonstrates that fear of representing Latino/as in a poor light prevents Gu Jun Pyo from participating in class discussions. Gu Jun Pyo mentioned perceptions of the Latino/a community both in school and in society in multiple interviews. She stated, "If you look a certain like a certain like a certain culture or something uh then they judge you based on that… Latinos are too dumb to actually succeed in this type of education, and I think they should just work in uh food drives and stuff and cleaning basically we just clean" (01/29/15). In one interview (02/17/15) Gu Jun Pyo discussed being perceived as "Oh, esa gringa" when she speaks English in one community and in another community, "I speak Spanish; they're gonna be like oh she might sell food or oh she's trying to steal this." These quotes demonstrate how Gu Jun Pyo's feelings of being judged inside and outside of class are influenced by how she feels that Latino/as are perceived in different communities.

In addition to expressing a fear of being perceived as incapable in class, Gu Jun Pyo also mentioned some challenges she faces as a result of being an L2 English speaker. When asked about planning her writing in English or Spanish Gu Jun Pyo said, “I’m usually like turning myself on like in the mornings I turn myself to English version and then Spanish version and sometimes Spanglish version.” Gu Jun Pyo also mentioned, “Sometimes I can’t express myself in Spanish, and sometimes I can’t express myself in English and that really like frustrates me because I’ve been here for so long and I’m like ugh” (01/29/15). In another interview Gu Jun Pyo discussed not knowing the English vocabulary needed to describe an experiment in her previous (eighth-grade) science class. The terms she didn’t know in English were not specifically scientific terms, but rather terms that native English speakers knew from outside of school.

Gu Jun Pyo’s discussions of her experiences in physics class, the school community, and communities outside of school demonstrate that she is highly aware of how she may be perceived by others in any given situation as a result of her language practices and assumptions people make about her culture and academic skills. Understanding Gu Jun Pyo’s perspectives on science, class participation and interaction with her peers in school provides the necessary context to examine her linguistic and other behaviors across three physics labs.

5.3.2 Lab 1 – Gu Jun Pyo from Good Assistant to Good Student

Gu Jun Pyo started Lab 1 in a good assistant position and slowly transitioned into a good student role, but she never occupied a position of science expert. The expertise hierarchy that solidified over time in this lab group was Alexander → Gu Jun Pyo → Manuel. Gu Jun Pyo was absent for part of the first[20] and the second iteration of Lab 1 (three cycles of lab design and testing, as described in Chapter 3). When she (re)joined a lab group on 12/10/14 the students in this group were collecting data for their third iteration of the experiment. Although Rico had initially been present in this group, he was absent on 12/10/14 and 12/11/14 and returned to the group on the day that they presented their results to the class 12/15/14. Unlike Rose's pathway which contains conflict as she oscillated between multiple social positions, Gu Jun Pyo's shift in identity resulted from an easily identifiable structural factor impacting her ability to be or be perceived as a *good student* or *science expert*.

In Lab 1 on 12/10 Gu Jun Pyo joined Alexander and Manuel's group after approaching the teacher to ask who she should work with since she had been absent. The teacher seemed frustrated and responded, "We've been working on this for three weeks. It's the group at your table." In Gu Jun Pyo's case the group at her table was not made up of her tablemates because of various student absences. However, Gu Jun Pyo immediately returned to her table and asked Manuel, "*Estamos en un grupo verdad*? [We're in a group right?] What did you guys do?" Manuel responded to Gu Jun Pyo in Spanish and they appeared to have a conversation about what Manuel's group had done

[20] My data on this lab started when Gu Jun Pyo was already absent as I missed the first iteration of the lab. I reconstructed based on other conversations about the lab that she had been present initially for the lab. I am guessing that she worked with Rico and Manuel at that time as those were her table group members and Alexander did not join the group until 12/09.

up to that point in the lab.[21] When Alexander, who was not present for the conversation between Manuel and Gu Jun Pyo, returned to the group, he asked where Rico was and then walked away again to confer with other students who were not in his lab group. Gu Jun Pyo turned to the teacher and said, “I’m lost,” to which he replied, “you’re not asking…you gotta ask questions.” Thus, the teacher, who may not have realized the extent of Gu Jun Pyo’s absences, put the responsibility of getting caught up on Gu Jun Pyo and expected her to do so by talking to her group members. Given the emphasis that Gu Jun Pyo and her family places on academics, it is likely that Gu Jun Pyo was anxious about the school days she had missed. This is also supported by her behavior early in the lab. Gu Jun Pyo attempted to get information about the lab from Manuel but it was not until a conversation with me 38 minutes into the period that Gu Jun Pyo expressed understanding about the goal of the lab.

Our conversation began with me asking Gu Jun Pyo if she had been absent due to sickness. Gu Jun Pyo told me that she’d had a family emergency and that she’d had to travel. This was the reason for her extended school absence. We then discussed the upcoming winter break. After these two topics Gu Jun Pyo asked me if the groups were giving presentations on the lab the next day in class. Gu Jun Pyo then said, “I really don’t understand what we’re doing.” I replied to Gu Jun Pyo, “I think, like so right now you’re just trying to improve the experimental design.” Gu Jun Pyo responded, “But what are we trying to find out?” Alexander and I started to respond at the same time to answer Gu Jun Pyo’s question. Alexander said, “intensity depending on distance.” Gu Jun Pyo responded “oh” with high pitched then falling intonation, indicating recognition. I continued to

[21] Manuel spoke very softly at all times and his voice is often barely audible on class recordings that contain background noise. Thus, it was impossible to reconstruct this conversation. The general topic is decipherable based on Gu Jun Pyo’s questions.

explain that the lab question was the same as the previous labs on this topic. Gu Jun Pyo then immediately resumed her *good assistant* task of reading numbers off of the LabQuest. Over time after this conversation Gu Jun Pyo gained confidence in participating in the lab and she eventually positioned herself as a *good student* through asking questions of the expert, providing suggestions for the wording of the poster (the poster replaced a lab report), and overseeing the writing on the poster, although content decisions were still made by Alexander.

Extracts 12 and 13 demonstrate Gu Jun Pyo's participation in the group before and after the conversation with me described above (respectively). Participants in the Extract include Alexander (A), Manuel (M), and Gu Jun Pyo (GJP).

Extract 12

GJP: Six twenty one. (2.0) five seventy six. Six twenty nine. (1.0) six twenty six. Six fourteen <*reading numbers from LabQuest*>
A: Kay how about one more=
GJP: =five seventy eight. Six twenty eight=
A: kay that's good. Um we just need to take an average of that? You know how to do it?
GJP: °Sure I need a calculator°
A: (Yeah/here) just get the average of that there. (4.0) Don't mess up.
GJP: I won't. (6.0) °five ninety eight° <*while punching into calculator*>
<*Alexander walks around to the front of the T desk and then stands on the desk. Manuel holds up the double taped meter stick. Alexander grabs the other end of the meter stick (19.0)*>
A: Can you hold that right at the center. <*(12.0) Alexander reads the meter stick, the end at the projector*> one forty five.
M: One
A: Write that down.
<*M leans towards the paper while GJP works on the calculator*>

In Extract 12 Alexander clearly articulates an expert role by controlling the number of data points collected (Line 222), nominating both Gu Jun Pyo and Manuel to complete tasks (Lines 225 and 232), issuing commands to Gu Jun Pyo and Manuel (Lines 228 and 235), and questioning (Lines 225-226) and commenting on Gu Jun Pyo's performance (command in Line 228). Alexander positions Gu Jun Pyo and Manuel as his assistants through these communicative acts and Gu Jun Pyo and Manuel confirm this positioning in their responses. However, Gu Jun Pyo offers some resistance to this positioning. In line 224 she responds quickly to Alexander's comment in Line 223 by barely allowing him to finish his request for an additional data point before reading the data aloud. In Line 227 Gu Jun Pyo responds quietly to Alexander's question about her ability to compute an average and in Line 229 when she responds, "I won't [mess up the average]," her tone indicates annoyance rather than enthusiasm. In contrast Manuel responds almost completely nonverbally to Alexander's actions and requests. He does what is asked of him without comment. Gu Jun Pyo operates as a *good assistant* by doing what is asked of her without disagreeing with the expert, until the conversation we had about the goal of the lab. Extract 13 comes from the phase of the lab where students were writing their results on posters. By the time this extract occurred Gu Jun Pyo had transitioned into a *good student* role, but she continued to defer to Alexander's scientific expertise.

During class on 12/11/14 students constructed posters that depicted their apparatus designs and data for each of the three cycles of the lab. Prior to the discussion shown in Extract 13 Alexander has given Gu Jun Pyo instructions on how to set up the poster. At this time Gu Jun Pyo still acts as a good assistant by asking clarification questions and doing as Alexander asks or tells her. By the start of Extract 13 Gu Jun Pyo is sitting at the group's table writing on the poster while Alexander sits on the neighboring table dictating statements for Gu Jun Pyo to write. Manuel alternates between standing at the table and walking away. When the students get to the hypothesis Alexander has trouble organizing his thoughts and telling Gu Jun Pyo what to write, which is evidenced by multiple false starts and pauses in his speech. Initially, when Gu

Jun Pyo attempts to offer a suggestion, Alexander talks loudly to continue his turn at talk and Gu Jun Pyo does not continue speaking. Gu Jun Pyo eventually becomes more involved in guiding the writing task as Alexander continues to express uncertainty in how to write the hypothesis. Part of the struggle here comes from an attempt to explain the rationale for the hypothesis based on the prior experiments. Participants in the extract include Alexander (A), Gu Jun Pyo (GJP), and Manuel (M).

Extract 13

GJP: We'll just put that we believe like=
A: Well
GJP: Having done an experiment beforeha- before no um
A: One second <*Alexander walks away*>
<*GJP and Manuel sit at the table, GJP says something quietly (inaudible) to Manuel and he walks away. I cannot see the teacher's desk but I believe Alexander is talking to the teacher. (38.0)*>
A: Okay (12.0)
GJP: Just tell me what you believe and I'll just write it
A: Yeah okay well, (2.0) first experiment we got well we were measuring area verses distance um we got a curve that was, one over x, and there we assumed that (2.0) um (2.0) if (4.0)
GJP: Let's not let's just make it simple.
A: Yeah but we gotta we gotta explain what we were thinking.
GJP: You wanna [explain the experiments we did before this one? That lead that lead to your hypothesis for this one
A: [Cause cause see what I'm I'm I'm saying is that we had like we had with (area) we had like a square of light, and <*leaning down to draw or write on the poster or paper*> that had an intensity of four times greater (like/light) than like a length of like twice this length cause it would have like four times more area (1.0) so we assume that that would mean that that square that second square would have (2.0) four times less intensity (2.0) <*looking at GJP*> cause it was spread out over four times more space (2.0) so we could write um (5.0)
GJP: Having done an exp[eriment before this dealing with
A: [Okay we could write like this we could write
GJP: area and what else?
A: and distance over distance and area ### so=
GJP: =we came to believe that
A: Well we can say we can (2.0) um say that (3.0) um (1.5) that area (4.0) of, hold on don't write it yet, that area of a square, is directly propor- is ah (5.0) relates directly to ah (2.0) intensity (2.0) so how much more area that much less light intensity. (2.5) Just how do we write it so it sounds good?
GJP: Okay we want it to sound good
A: Okay let's try let's try this so start writing um (3.0) based on a prior experiment (1.5) measuring (2.0)
<*Sarah suggests that the students draft the hypothesis on a separate sheet of paper before writing it on the poster*>
GJP: Okay so like based on a prior experiment which <*writing*>
A: Which showed that um…<*Alexander continues*>

In Lines 1 and 3 Gu Jun Pyo offers a suggestion for how the group might start the hypothesis but she expresses uncertainty at the end of Line 3 with a verbal repetition and the use of “um.” She also fails to include any technical or scientific information in her utterance. Alexander leaves the group (likely to speak with the teacher) but when he returns he still expresses uncertainty in what to write with a long pause (Line 8), to which Gu Jun Pyo offers another suggestion for how to proceed telling Alexander to tell her what he believes (Line 9). This command is related to task completion as opposed to science content per se. Alexander obeys Gu Jun Pyo’s command and begins a technical explanation in Line 10, which he finishes with uncertainty as indicated with “um” and multiple pauses (Lines 11-12). Gu Jun Pyo again attempts to fill in and guide the task in response to Alexander’s uncertainty (Line 13). In Line 15 Gu Jun Pyo begins to direct Alexander by asking a question and by continuing to articulate her thoughts after Alexander interrupts what she is saying (Lines 15-18). In these lines (i.e., 15-18) Gu Jun Pyo uses the pronoun “you” twice as she continues to defer scientific expertise and authorship of the hypothesis to Alexander. After his technical explanation in Lines 17-23 Alexander seems to open his ideas to comment by Gu Jun Pyo by looking at her and by the three pauses spread over Lines 22-23. Each of these pauses could be viewed as an invitation for Gu Jun Pyo to negotiate science content with Alexander. However, Gu Jun Pyo stays silent at first and then responds by offering possible phrasing in Line 24 and by asking for clarification on the science content in line 26. In addition to the pauses and instances of “um,” Alexander also signals uncertainty and decreased epistemic authority in Lines 31-32 where he asks, “Just how do we make it sound good?” In Line 33 Gu Jun Pyo offers agreement that they want the hypothesis to sound good and the negotiations of how to write the hypothesis continue in a similar format to what is described above in Lines 38 and 39 and in subsequent turns at talk after Extract 13.

After this exchange the group continues to struggle with writing a suitable hypothesis. Eventually, Alexander ends up taking over the task of writing the hypothesis completely, and he finishes it while the other students leave for lunch. Alexander's hesitations mainly articulated through fillers such as "um," pauses, and some statements and questions that decreased his epistemic authority (e.g., Lines 31-31) served as invitations for Gu Jun Pyo to participate in the negotiation of science content knowledge and technical language. Most of Gu Jun Pyo's responses to these invitations focused on general wording of the hypothesis and what might be considered "academic language" as opposed to science content and technical or scientific knowledge. Thus, Gu Jun Pyo signaled that she was a good student in these interactions, but that she did not have the background knowledge necessary to engage in a scientific discussion.

This lack of technical knowledge resulted from the way that Gu Jun Pyo joined this lab group and the lack of access she had to learning based on not being present for all iterations of the lab. Part of the reason for Gu Jun Pyo's lack of background knowledge stemmed from the teacher's insistence on Gu Jun Pyo learning what she had missed from her group as opposed to from him or through some form of structured interaction. These interactions demonstrate that without structure to facilitate equitable participation in lab tasks, it can be difficult for even top students to develop expertise when working in a group. Though Alexander has the skills to demonstrate epistemic authority, he is not a "teacher" for his peers, and thus actual teachers must intervene either personally or through creating structures for participation in small group tasks like lab-work to ensure that these learning experiences serve to build expertise for all students as opposed to simply reinforcing the expert role for students from predictable backgrounds. As listed in Table 3.1, Alexander's parents are well-educated engineers. They also required him to study science topics online outside of school. Although I am unsure of Gu Jun Pyo's parents' professions, in our extensive conversations she mentioned only talking with her older sister explicitly about science content.

5.3.3 Lab 2 – Gu Jun Pyo as a Good Student and Science Expert

Throughout Lab 2 Gu Jun Pyo consistently articulated a good student identity and she co-occupied the expert role with Rico. Thus, the expertise hierarchy in this lab group was Gu Jun Pyo & Rico → Manuel. In this lab Gu Jun Pyo characterized herself as a good student and her male peers as bad or unserious students. Participants in Extract 14 include Gu Jun Pyo (GJP), Rico (RI), and Manuel (M).

Extract 14

GJP: You guys either work or you guys fail.
(15.0)
GJP: A mi no me importa si van a pasar ## <*Eng: I don't care if you pass or not*> you guys keep doing this, cause I'm not going to do it and when you guys need to copy off of my paper you guys won't because you guys aren't working. So get a piece of paper and get a pencil and start writing the question down.
RI: What are you talking about? We're we're clearly doing this and we are clearly ah [discussing
GJP: [You guys have to you guys have to maintain your own logs (or like whatever)
RI: We are clearly discussing, you know what we're discussing right now? We are discussing how are we going to measure distance. Okay but no you're not in this group. (5.0) <*Manuel walks away to his bookbag*> Manuel Look we even got the thing of salt. Have you got it? No. Why?
GJP: We're the same group so you ## got what I needed. (20.0) °We believe that (3.0) if we keep the electric # at a maximum° <*probably writing*>

In Extract 14 Gu Jun Pyo consistently set up statements using "you guys" as the subject with the predicates, "work or fail" (Line 57), "keep doing this [playing around]" (Line 60), "need to copy" (Lines 60-61), "aren't working" (Line 61), and "have to maintain your own logs" (Line 65). Each of these statements positioned the boys as bad students and Gu Jun Pyo as a good student who exhibited the opposite behaviors. Gu Jun Pyo issued a command to the boys to "get a piece of paper and get a pencil and start writing the question down" (Lines 61-62). These statements characterize Gu Jun Pyo as a good student who is on-task and the boys as bad students who are playing around and not being diligent. Rico contested this positioning but he aligned himself with Manuel by using "we're" as the subject of his contestations[22]; "clearly doing this [collecting materials for the lab]," "clearly discussing." It was not uncommon for Gu Jun Pyo to explicitly comment on and negatively sanction Rico and Manuel for off-task behavior during this lab.

In addition to characterizing herself as a good student and repeatedly commenting on task completion and the behaviors of her peers, Gu Jun Pyo also demonstrated science expertise throughout the lab during lab setup and data collection phases. Extract 15 demonstrates how Rico and Gu Jun Pyo negotiated expertise and came to consensus during lab setup and data collection. In Extract 15 the students were measuring the distance between the balloon and the scale as they collected data. Participants in Extract 15 include Rico (RI), Manuel (M), and Gu Jun Pyo (GJP).

Extract 15

202 RI: So make our line right there and start from there
203 GJP: Make the line
204 RI: Manuel (3.5) make the line right here. O:r we could just measure this
205 (5.5)
206 GJP: This is centimeters
207 (4.5)
208 RI: I would say

[22] Although it goes beyond the scope of the analysis presented in this dissertation, it is possible that gender-based identities played a role in how students constructed themselves as good students. Girls in this classroom seemed more likely to verbally sanction boys for off-task behavior than the opposite.

GJP: Seven and a half?
RI: No (2.0) I would say eight but=
GJP: =eight
RI: No.
GJP: Let’s see okay um: <*GJP leans in to look at the ruler and paper*> yeah it’s eight.
RI: Okay <*Rico and GJP look at the scale, Manuel touches balloon to Rico’s head*>
GJP: There. We’re starting from there. (2.0) Remember we’re trying to record as much as data as possible cause today is the only day we get.

In Lines 202 and 203 Rico and Gu Jun Pyo issue commands to Manuel about making a line to assist in measuring the distance thereby positioning themselves as experts and Manuel as their assistant. In Line 204 Rico offers an alternative approach to which Gu Jun Pyo issues a correction by pointing out that the scale on the ruler that students should be using is centimeters (Line 206). In Line 208 Rico prepares to offer a suggestion but reduces the epistemic authority of his suggestion by using the modal verb “would.” In response to this uncertainty Gu Jun Pyo offers a possible measurement in Line 209. Rico disagrees with certainty in Line 210 but then again expresses uncertainty in his suggestion of 8 centimeters by using the modal verb “would” and “but,” as opposed to a declarative sentence, such as “It’s eight.” In Line 211 Gu Jun Pyo offers agreement with the reading of eight, which Rico again disagrees with using “no” (Line 212). As a result of the uncertainty expressed by Rico, Gu Jun Pyo offers her own independent measurement in Lines 213-214, which she claims with certainty, “Yeah, it’s eight.” Rico accepts Gu Jun Pyo’s assessment of the distance in Line 215. Gu Jun Pyo then rearticulates her status as the resident *good student* by reminding her peers that they need to collect their data by the end of the current class period (Lines 216-217).

Extract 15 demonstrates the way that students agree and disagree with each other and create consensus sequences when they share expertise. These conversations were only present in situations where two students co-occupied the top position in the expertise hierarchy. Gu Jun Pyo's interactions in Extract 15 demonstrate how she articulated both the *good student* and *science expert* identities during this lab.

5.3.4 Lab 3 – Gu Jun Pyo from Science Expert to Disruptive Student

In Lab 3 Gu Jun Pyo started as the group's science expert through her use of technical explanations, demonstrations of epistemic authority and content knowledge, and interactions as the group spokesperson with the teacher. However, after Captain America joined the group, Gu Jun Pyo slowly became repositioned as less of an expert than Captain America. One moment that exemplifies this occurred relatively early in the lab setup phase of Day 2 when OneDirectioner repeatedly asked her peers how to change a setting on the LabQuest. When OneDirectioner directed the question to Gu Jun Pyo she said, "We don't, I never handle the ## [LabQuest]." By not knowing how to use the lab computer, Gu Jun Pyo becomes repositioned as having less expertise than Captain America regardless of their ideas about how to measure the speed of a wave in this lab. As a consequence of not being able to use the LabQuest, Gu Jun Pyo lost the opportunity to determine the acceptability of the data students collected in real time. The person who controls the LabQuest develops the expertise of data interpretation and has the social role of controlling the data collection process. Because they did not know how to use the LabQuest this role was denied to each of the focal participants in this study.

In addition to losing her position as the science expert in the group via not knowing how to use the LabQuest, Gu Jun Pyo also lost expertise when OneDirectioner was a more consistent rope striker than she was. Gu Jun Pyo's joking comments indicated that she was unhappy about this loss of group status. Gu Jun Pyo engaged in more off-task behavior in this lab than in her participation in Labs 1 and 2. Though there are likely multiple reasons for this (e.g., working with close friends), her playful interruptions and distractions appeared to be a subversive response to her decrease in power. Extract 11 demonstrates Gu Jun Pyo's subversive playfulness and her attempts to position herself as having expertise.

In Extract 11, Lines 605-606 and 609, Gu Jun Pyo's first contribution to the discourse is to talk to Rose about the meter stick that Rose has been playing with and poking Gu Jun Pyo with. Gu Jun Pyo's first comment related to science appears in Line 615 when she asks OneDirectioner to record the data for her. There is no reason why Gu Jun Pyo could not have recorded her own data. Thus, this request serves as an attempt to position herself above OneDirectioner in the social hierarchy after OneDirectioner has demonstrated her superior capability in striking the rope consistently. In Line 620 Gu Jun Pyo playfully nominates herself to strike the rope and she positively evaluates the resulting data in Line 627, "these are perfect!" The responses of the other girls indicate that the data were not perfect and in Line 633 Gu Jun Pyo pleads with her peers for another chance to strike the rope. Gu Jun Pyo tells her peers "I won't hit it wrong, it's impossible" in Line 636 and in Line 638 Captain America confirms that the data were of acceptable quality. This interaction demonstrates the social negotiations that are tied up in constructing science meaning during physics labs. As students develop data collection skills and evaluate the accuracy and acceptability of data, they also negotiate roles in a social hierarchy. In Lab 3 Gu Jun Pyo maintains her position as second in the expertise hierarchy not because of her lab skills but instead because of the way she denies OneDirectioer a particular role in collecting data.

5.3.5 Summary of Gu Jun Pyo's Pathway of Social Identification and Learning

Gu Jun Pyo participates in dramatically different ways across the three labs (depicted in Figure 5.3). In the Lab 1 she moved from a *good assistant* to a *good student* role but she was not able to develop science expertise in this lab due to her absences and the requirement created by the teacher that she learn what she had missed from her peers. In Lab 2 Gu Jun Pyo confidently occupies both a *good student* and a *science expert* role. In Lab 3, Gu Jun Pyo occupies an expert position until it is challenged by Captain America and she spends the remainder of the lab disrupting data collection as a result of this positioning. The key structural factors that determined Gu Jun Pyo's social status and ability to construct science expertise were, how the teacher dealt with her absence in Lab 1, her ability to demonstrate epistemic authority in Lab 2, and her lack of knowledge of how to use the LabQuest in Lab 3.

5. 4 Looking Across Socialization Pathways

Looking across the socialization pathways of the Latina students described in the previous sections reveals four generalizations related to social positioning and learning in this physics class. First, classroom identities are co-constructed among peers in lab groups. The portraits provided in the previous sections demonstrate the relationship Sewell (1992) describes between structure and agency whereby "structures…are constituted by mutually sustaining cultural schemas and sets of resources that empower and constrain social action and tend to be reproduced by that action" (p. 27). Sewell continues by stating "agents are empowered by structures, both by the knowledge of cultural schemas that enables them to mobilize resources and by the access to resources that enables them to enact schemas" (p. 27). In the trajectories described for Rose, OneDirectioner, and Gu Jun Pyo the girls' ability to "mobilize resources," in this case, linguistic resources, to "enact" particular schemas, or in this case, ways of being or identities, was constrained by the identity work of their peers. In Rose's and OneDirectioner's pathways, Satan, Potato, Captain America, and Gu Jun Pyo served as gatekeepers positioning them in less powerful positions in the expertise hierarchies. For Gu Jun Pyo, Alexander, Mr. H, and Captain America actively positioned her in social roles as less knowledgeable than her peers. Using Sewell's (1992) terminology, Captain America, Alexander, and Potato were empowered as experts by using a set of resources (linguistic and other) that simultaneously constrained the possibilities for social action and positioning afforded to Rose, OneDirectioner, and Gu un Pyo. The three pathways described above show how identities are truly co-constructed and cannot be explained by considering only speaker agency.

Second, building on the points made above, students' socioeconomic status and exposure to science careers at home likely provided them with the background and experiences, or in Sewell's (1992) terms, "cultural resources and sets of schemas" to be science experts in school. In this case study, we saw that Captain America, Alexander, and Potato all regularly occupy science expert positions during lab work, and they are all White, from middle-class backgrounds, and have scientist parents. When we examine the pathways of Rose, OneDirectioner, and Gu Jun Pyo we see that they struggle to articulate positions of expertise in groupings where Captain America, Alexander, or Potato are present. This case study demonstrates the types of interactional moves that Captain

America, Potato, and Alexander mobilize through linguistic acts to construct positions of expertise. This process directly demonstrates the reproduction of social structures and hierarchies from outside of school in the classroom community. The cases presented here demonstrate the reproduction of social hierarchies in action with children through peer socialization. As such, this case study demonstrates missed opportunities for disrupting this process of regenerating social, racial and linguistic hierarchies. If schools are to be equalizers, we must develop and provide teachers and students tools to work against this social reproduction in order to create social change. I provide suggestions to this effect in Chapter 6.

Third, Spanish and Mock Spanish served as important resources for identity construction in this science classroom and for the aforementioned reproduction of social hierarchies. For both Rose and OneDirectioner, the instances of Mock Spanish in Lab 1 delivered by Potato and Satan, and the racializing conversation about hair in Lab 2 served to deny Rose and OneDirectioner access to developing science expertise by limiting their participation in scientific discussions as equal status group members. Hill (1999) discusses the ways that Mock Spanish racializes speakers from Spanish-speaking backgrounds and works as a tool to police and protect a White Public Space (WPS). In the WPS, Mock Spanish directly indexes a cosmopolitan persona for White speakers at the same time that it covertly or indirectly indexes negative stereotypes of actual Spanish-speakers (Hill, 1999). When Spanish-speakers speak in Spanish in the WPS they are met with fear and rejection by Whites (Hill, 1999). Potato's use of Mock Spanish and his explicit claims to having a brother living in Mexico and speaking Spanish himself portray him as the archetypal speaker of Mock Spanish – a White middle class male who wants to be viewed as worldly and culturally savvy. Though it is clear that Mock Spanish served a gate-keeping function in Lab 1, what is unclear in this community is the degree to which the use of Mock Spanish is ideologically linked to the science expert persona in this classroom community. Determining the larger role of Mock Spanish in this classroom community will require additional research and a broader corpus than the one used for this study. The findings from the three socialization pathways suggest co-indexation of science expert status with Whiteness, being popular, and coming from a middle class background, and the co-indexation of speaking Spanish with being a good assistant. Based on the findings presented here is it plausible that students' use of Mock Spanish represents one way that these ideological links are built and regularly rearticulated in this classroom community. Again, more research is needed to further explore this claim.

Fourth, despite the focus on peer socialization in this study, the teacher's instructional choices directly and indirectly impacted students' negotiation of expertise and their identity development in peer groups. Mr. Henderson shaped peer interaction by allowing students to negotiate the social roles involved in lab work without intervention, by requiring students to learn what they had missed after school absences from their peers, and by failing to provide explicit instruction on how to use the lab computers. Each of these three instructional choices resulted in negative consequences for identity development for the three Latina students in this study.

We see from the trajectories of three Latina students that in all cases where a White middle class student with scientist parents was present in the group, that student became the resident science expert of the group. Thus, the lack of instruction for how groups should function to complete lab tasks allowed for the reproduction of the social hierarchies that existed outside the classroom. I do not intend to criticize Mr. Henderson for this oversight as it is common practice in science classrooms to allow students to figure out how best to work with one another. With the pathways presented here, I endeavor to show possible consequences of this instructional approach so that all teachers might begin to consider how a hands-off approach to group work can marginalize students from certain backgrounds.

In addition to allowing peers to negotiate lab tasks without intervention or structure, by expecting students to learn what they had missed from their peers after absences from school, the teacher perpetuated inequitable relationships among group members. Gu Jun Pyo's inability to participate as an expert in Lab 1 directly resulted from this practice of requiring students to learn what occurred in previous class sessions from their peers. This practice may negatively impact students with lower socioeconomic status (SES) who disproportionately experience more school absences than their middle and high-income peers (Ready, 2010).

Finally, the teacher's reliance on students to figure out how to use the LabQuests without direct instruction resulted in an asymmetry of technological skills that exacerbated the construction of expertise hierarchies and impacted students' access to developing science content knowledge. It is unclear how the science experts learned to use the LabQuests. From observing classes in the seventh-, eighth-, and ninth-grade classes at SFAA over the course of 2 years, it is my guess that students who reliably occupied science expert positions in ninth grade had done so in previous years of school science as well. I imagine that when students were introduced to the lab computers in younger grades, the science experts took the lead in learning how to use them. As a result of occupying the science expert role over time, these students developed confidence, skills, and knowledge in how to use the devices. This opportunity was denied to the other students because they did not occupy the science expert position. Thus, I believe there is a mutually reinforcing snowball effect with the LabQuests. The science experts continue to maintain and rearticulate their expertise because they know how to use the lab computers; however, they may have been the ones to learn how to use them in the first place because they were already occupying positions of science expert status in their groups. Regardless of how the science experts came to know how to use the lab computers more competently and confidently than other students, teachers have a role to play in intervening in peer learning to ensure that all students have access and opportunities to develop certain skills. I provide recommendations for how teachers might do this in Chapter 6.

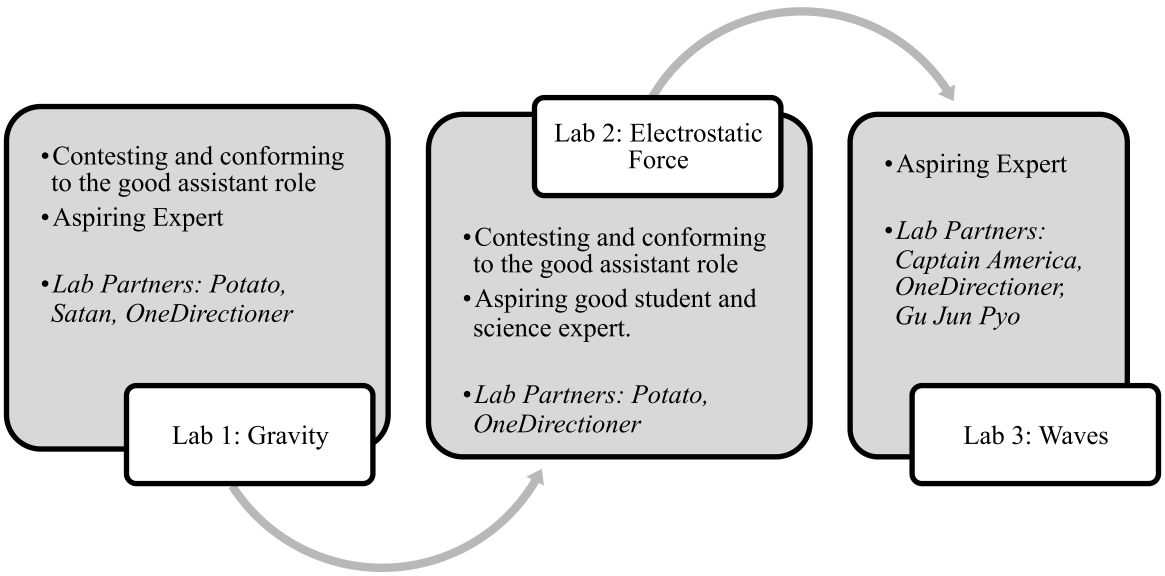

Figure 5. 1 Rose's Pathway of Social Identification

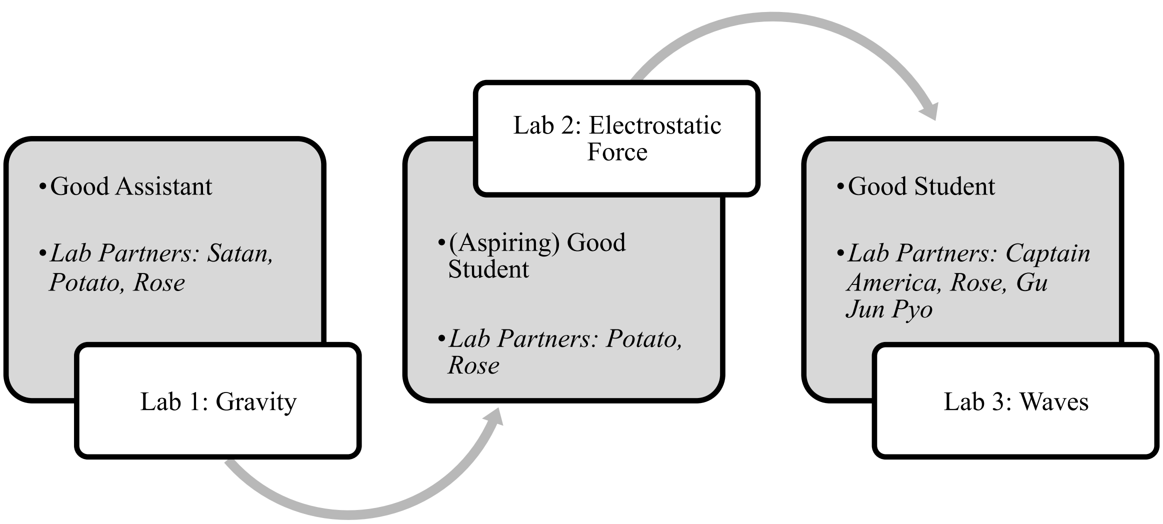

Figure 5. 2 OneDirectioner's Pathway of Social Identification

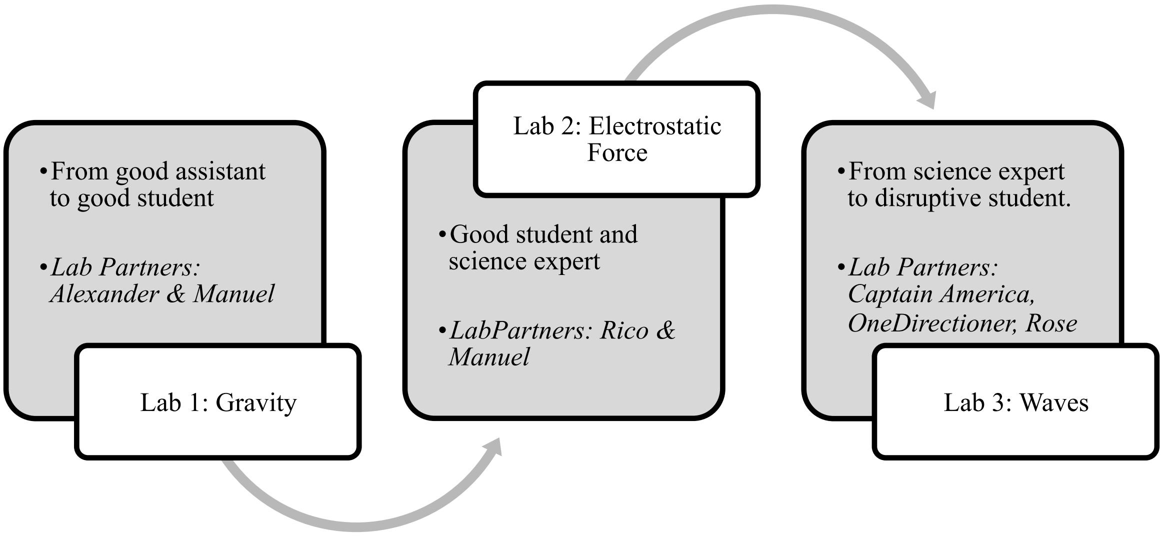

Figure 5. 3 Gu Jun Pyo’s Pathway of Social Identification

CHAPTER 6

DISCUSSION

OneDirectioner's, Rose's, and Gu Jun Pyo's identity pathways demonstrate how different students in one ninth-grade physics class navigated the social and linguistic demands of inquiry instruction. The pathway-based analysis in Chapter 5 revealed how students' identities as Spanish speakers and Latinas intersected with their positioning as good assistants (Rose and OneDirectioner in Labs 1 and 2). With the exception of Gu Jun Pyo who successfully articulated a science expert position in Lab 2, the girls were generally prevented from participating in labs as experts by their own choices and actions, by positioning imposed on them by other group members, and as a result of structural factors implicitly created by the teacher's instruction. The following subsections address the implications of these findings for research on Latino/as in STEM (Section 6.1), for classroom discourse studies (Section 6.2), for language socialization research (Section 6.3), and for science teacher education (Section 6.4). I conclude this dissertation with final thoughts and future directions in Section 6.5.

6.1 Implications for Latino/as and Language Learners in STEM

OneDirectioner's and Gu Jun Pyo's interview comments and the experiences of OneDirectioner and Rose in Labs 1 and 2 demonstrate that students' identities as

Spanish-speaking Latinas related to their inability to achieve science expert status in peer groups. In Labs 1 and 2 Rose and OneDirectioner were positioned as less scientifically literate than their peers. Although some of this positioning was not directly related to race or language background, Satan and Potato's uses of Mock Spanish (Hill, 1999; 2008) in Lab 1 and the discussion about hair and "Americans" in Lab 2 provided ideological links between speaking Spanish fluently and the social role of the *good assistant*. These examples demonstrate the subtle ways in which students' racial and linguistic backgrounds can inform peer group interaction and the development of science expertise.

Ideological links between speaking Spanish and the *good assistant* role may have been created or reinforced, though implicitly, through Gu Jun Pyo's participation in Lab 1. When she began the Lab, Gu Jun Pyo discussed lab content with Manuel in Spanish, but she was not able to develop the necessary background knowledge to participate in the lab as an expert from this conversation. It was not until my conversation with her in English that Gu Jun Pyo was able to begin rearticulating a position for herself in the group as a good student. Gu Jun Pyo's pathway out of the *good assistant* role rested on her ability to navigate the science content in English. In some ways, students occupying good student roles are simply high-level assistants for the science experts in the group. When Gu Jun Pyo moved into the good student role she still took directions from Alexander and deferred to him as a science expert. This example shows again how subtle interactions among students helped to create or reinforce ideological links between the *good assistant* role and Spanish-speaking students. The only lab in which Gu Jun Pyo was able to maintain her status of being a science expert (co-occupying this role with Rico) was Lab 2 in which her partners were both Spanish-speaking Latinos.

Although working in a peer group with other Latino students allowed Gu Jun Pyo to develop and articulate a position of expertise, her actions also constrained the ability of other Latino/a students to develop expertise. For example, in Lab 2, Gu Jun Pyo and Rico used English almost exclusively during the Lab despite the fact that Manuel did not speak very much English and that they are all bilingual. Rico and Gu Jun Pyo apprenticed Manuel into the classroom culture where Spanish was the language of *good assistants* not *science experts*. In addition, Gu Jun Pyo actively worked against OneDirectioner surpassing her in the social and expertise driven hierarchy in Lab 3. When Captain America attempted to supplant Gu Jun Pyo with OneDirectioner as the rope striker (Lab 3, Extract 11), Gu Jun Pyo contested this reassignment of roles. Though delivered in a joking manner, Gu Jun Pyo's comments during this phase of the lab demonstrate her dissatisfaction with being evaluated as ineffective in helping to collect data.

Taken together, the girls' socializing experiences demonstrate intersections between speaking Spanish and being positioned as a *good assistant* during inquiry instruction. However, the girls' individual pathways demonstrate the different ways that students navigated the connection between language background and science expertise. What do these cases tell us about the underrepresentation of Latinos/as in STEM? Using the pipeline (Lewis et al., 2009) or pyramid (Rochin & Mello, 2007) metaphors, we see that social dynamics in high school inquiry tasks may represent a barrier in the pipeline to STEM careers for some Latino/a students. When students from Spanish-speaking and English-speaking backgrounds are left to navigate social interactions during inquiry instruction without interventions or monitoring from the teacher, even high achieving Latina students can become relegated to menial tasks and denied opportunities to develop science expertise. Supporting Latinos/as to overcome this barrier to STEM participation at the high school level will require interventions in the social dynamics of collaborative learning during inquiry tasks. (I discuss strategies for accomplishing this in Section 6.4.) We cannot conclude from the case presented here from one high school physics classroom that all Latinos/as in diverse schools are impacted in the same way by the social dynamics of the classroom. However, this case provides one window into peer language socialization which researchers, teacher educators, and teachers may use to consider barriers to participation for Latinos/as in STEM education in other settings.

6.2 Implications for Classroom Discourse Studies

The results described in Chapters 4 and 5 demonstrate that peer interaction during lab tasks serves an important role in facilitating students' development of science expertise and the *science expert* persona. Classroom discourse analysis studies that focus on whole class discussions at the exclusion of peer group interaction fail to account for all of the relevant discourse in a classroom. During my observations in this one ninth-grade physics class Rose and OneDirectioner, and many other students, only participated in whole class discussions when nominated by the teacher. These nominations took place infrequently, which means that the same five to six students dominated whole class discussions. Thus, studying classroom discourse socialization from the perspective of whole class discussions would have provided limited insight into the identity development and classroom experiences of the Latina students in this study. Research that partners explorations of whole class dynamics and teacher-led discourse with the discourse of peer interaction will ultimately provide researchers and teacher educators with a more comprehensive understanding of how students are socialized into or out of various ways of speaking in classrooms.

Revisiting the features of science discourse described in whole class settings by Lemke (see the nine features outlined in Chapter 2) we see that students' performance of the science expert role during peer interaction in this study included two of the nine features: (1) be as verbally explicit and universal as possible, and (3) use technical terms in place of colloquial terms. Although students did not necessarily make generalizations, student science experts in lab groups did use explicit language and physics terminology when possible. Revisiting other aspects of science discourse discussed in Chapter 2 reveals that students did not use nominalizations, objectifying language, or formulaic expressions in the lab setup and data collection phases of labs. Students used these features of science language when writing lab reports and presenting their findings. However, in Labs 2 and 3 students completed these phases of the labs independently, outside of class. Of the features of science discourse described in Chapter 2, science vocabulary and epistemic authority were important components of students' use of science discourse during all phases of science inquiry projects. In addition, Table 4.1 summarizes a number of additional communicative practices that characterized student *science experts* such as issuing directives, using silence strategically, controlling materials, and evaluating peer performances.

The case study presented in this dissertation reveals the vast array of linguistic skills that are required for students to demonstrate science expertise in their peer groups. This research shows what language learners in one setting must learn to do linguistically and culturally in order to build science expertise and negotiate science content with their peers. For those concerned with promoting equity in science education there are two possibilities for how to use this information. First, one might consider how teachers could teach language learners in content classes to develop the range of communicative behaviors that are important for peer interaction. One cautionary point here stems from the fact that two of the three focal participants in this study were bilingual learners, not students identified as English Language learners by the school. Thus, any attempt to teach students how to develop an expert persona must address all types of language minority learners, not just those officially classified as Limited English Proficient. Second, one might consider how to influence peer group dynamics so that a different set of communicative behaviors becomes central when negotiating science meaning, for example, asking for peer input. For content teachers who regularly work with linguistic and racial minority students and for teacher educators who endeavor to prepare teachers for working with diverse learners, this case study demonstrates some of the factors that impact classroom learning that are often unaddressed in teacher preparation programs. In order to provide teacher educators with the information needed to develop new methods for teaching their students, classroom discourse researchers must develop ways to integrate analyses of whole class and peer-led classroom discourse. By providing a detailed account of science discourse from peer interactions this dissertation moves researchers one step in this direction.

6.3 Implications for Language Socialization Research

This dissertation makes two contributions to LS research. First, the cases presented here of three students' socialization pathways demonstrate the lack of inevitability in the transition from novice to expert status. Second, this case demonstrates how social positioning and one's status as bilingual can impact language use opportunities in a science classroom. In Rifkin and Martin's (2004) analysis of the negotiation of expertise during a water board hearing, the authors demonstrate how multiple people engage in the construction of the expertise of two possible science experts. The Water Board accepted only one interpretation of the facts, which they arrived at after collecting public testimonies by a community-hired science expert and an industry-hired science expert. The authors demonstrate how the community-hired expert claimed a superior expert status through the use of interruptions and interjections during the testimony of the industry specialist. It was the expert's ability to manipulate the social setting as opposed to his superior chemical analytic skills that led his testimony and suggestions to be accepted by the Water Board.

Unlike the Water Board meeting where one expert may expect his or her expertise to be ratified or valued more than another expert, by modern standards classrooms are not intended to present such a ranking. Theoretically, teachers endeavor to prepare all of their students to be successful academically and in their specific disciplines. Setting aside tensions between a "Science for All" perspective and institutional structures that lend themselves to ranking students (e.g., GPAs, class rank, and norm-referenced grading), classrooms, and the teachers that guide them do not have a default goal of locating or producing solitary experts. Rather, the goal of public education and most public educators is to produce many potential experts. Indeed it is the purpose of this dissertation to understand how the opposite occurs – how the endeavor of creating multiple potential future experts often leads to the cultivation of the expertise of only a few students from predictable backgrounds. From the cases described in this dissertation we see examples of the social positioning that Latinos/as must overcome in order to develop science expert status and thus gain access to negotiating science content and technical scientific language.

When the students in this study came together in lab groups they negotiated expertise and created local somewhat flexible expertise hierarchies. Students' degrees of identification with the *science expert*, *good student*, and *good assistant* identities helped to position them in these hierarchies. For example, in Extract 7, we saw the formation of an expertise hierarchy of Potato (most expert) → Satan → Rose → OneDirectioner (least expert). In the whole class setting Potato was a *good student* directing technical questions to the teacher who was the *science expert*. As soon as students formed small groups, Potato became the *science expert* in his group. The pathways analyzed in Chapter 5 further address the relationships between students' positions in the expertise hierarchies and their corresponding opportunities for learning.

The interviews with OneDirectioner and Rose revealed that they liked working with Potato and Satan despite the fact that they were not able to become science experts when working in this peer group. Though Potato and Satan may have provided OneDirectioner and Rose some access to building science content knowledge through exposure to their thought processes, neither Rose nor OneDirectioner earned good grades in physics class. Rose and OneDirectioner's incidental learning during labs did not transfer to being able to demonstrate expertise and understanding in other aspects of the physics course. It seems possible that Rose and OneDirectioner's time as good assistants could serve to apprentice them into science expert roles in the future. However, two factors point to the lack of inevitability in their achievement of science expert positions in the future. First, Rose had been a student at SFAA since the sixth grade. She had already experienced 3 years of exposure to science inquiry in peer groups, and this was not enough for her to become recognized as a science expert despite her positive orientation to science and her desire to socially affiliate with students who were regularly identified as science experts in the class. Second, Gu Jun Pyo had also attended the school since sixth grade. Though she was able to articulate a science expert role with Latino/a lab partners and had exemplary grades in the class, her status as a science expert was challenged in lab groups with Alexander and Captain America.

The examples provided in Chapter 5, which trace the pathways of lab group participation of Rose, OneDirectioner, and Gu Jun Pyo, demonstrate how expertise hierarchies were created, maintained, and disrupted in five lab groups across three lab tasks. Although there are similarities between the way that these ninth-grade physics students negotiate expertise and the practices of undergraduate engineering majors described by Vickers (2007), I chose not to analyze degrees of expertise using her participation continuum (theorized by Lave & Wegner, 1991). For advanced undergraduates with declared majors there is a likelihood that these students will be conferred an institutional label of “scientist” regardless of how fully they participate in their design projects, as long as they meet the degree requirements. In this context it makes sense to look at students’ participation as varying degrees of membership in the scientist community, which they are seeking to become a part of by earning their degrees. For high school students taking a mandatory physics class, we cannot assume that students are on track to become scientists, even students at a science-focused school.

High school science is more removed from the contexts of actual scientists than undergraduate programs where students directly interact with scientists (their professors and advisors at internships). Successful participation in the high school science classroom community has multiple possible targets associated with success (e.g., the three identities described in Chapter 4) as opposed to one identity goal such as "core member" (or full participant according to Vickers, 2008, and Lave & Wegner, 1991).

Though the *good assistant* role provides students with opportunities to actively participate in labs, this participation excludes verbally negotiating science content knowledge. Rose, OneDirectioner and Gu Jun Pyo's trajectories each demonstrate the challenges students faced in attempting to navigate out of the *good assistant* position in lab groups. It seems likely that certain students could spend their entire high school career occupying the *good assistant* social role during labs and thereby be denied the chance to develop science expertise at the same level as their *science expert* peers. Rochin and Mello (2007) suggest that in order to become successful scientists, students must cultivate an appreciation of and skills for conducting scientific inquiry as well as skills in science leadership and teamwork. Chemers (2006, as cited in Richin & Mello, 2007) states that science leadership and teamwork "includes establishing and communicating vision, developing and using resources . . . and leading and participating in group processes, such as decision making and delegation." Students in this ninth-grade physics class who occupied the *science expert* role in their lab groups were already cultivating these science leadership skills. Thus, without opportunities to occupy the science expert role in their lab groups some students leave high school science with fewer skills to prepare them for careers in STEM than other students. LS researchers who endeavor to identify opportunities for students to become members of expert communities may consider applying a similar approach to the one outlined in this dissertation to investigate the variety of social roles that students occupy in classrooms. In addition, the concept of an expertise hierarchy may be useful to LS researchers as a way to move away from dichotomous labels of "novice" and "expert" which do not capture the range of success-related identities that students may occupy in various contexts.

6.4 Implications for Science Teacher Education

This dissertation presents a case documenting the social interactions that students must engage in while constructing knowledge during science inquiry investigations. The pathways of socialization of OneDirectioner, Rose and Gu Jun Pyo during collaborative work in lab groups demonstrate opportunities where teachers might influence students' pathways to promote alternative outcomes, i.e., more equitable access to developing a science expert persona and the attending opportunities to negotiate science content and use technical language. As I have suggested in the preceding subsections, teachers and teacher educators have two options for how to make use of this information in order to create more equitable classrooms that support Latino/a students in overcoming barriers to their success in STEM education. The two approaches are not mutually exclusive. They include (1) making the language of success in peer group interactions explicit and the object of direct instruction; and (2) using instructional methods to change the values in the classroom community so that alternative communicative practices become essential to developing science expertise. I provide suggestions for preservice and in-service teacher education in the subsections below. It is my hope that teachers and teacher educators will employ these strategies as a way to promote equitable participation in science lab tasks and equitable access to science expertise for bilingual Latino/a students and other students from minoritized backgrounds.

6.4.1 Instruction on the Language Demands of Collaborative Tasks

As part of their preparation to work with language minority students, preservice and in-service science teachers may enroll in courses aimed at teaching them how to integrate content (science) and language instruction. In this context, teachers often learn to identify the language demands of content-area instruction and to make those demands the object of instruction by writing language objectives and designing related instructional tasks around these language demands (e.g., the SIOP Model, Echevarria, Vogt & Short, 2013). While content and language learning are inextricable, producing separate content and language objectives can be a useful tool for teachers to begin to recognize the ways that language and content learning are intertwined. I advocate for teacher educators to consider preparing teachers to recognize three categories of classroom language demands: text comprehension, text production, and interaction. Within the domain of interaction, teachers must become sensitized to the ways that students articulate and negotiate power and social status. The information in this dissertation about how students interact in peer groups without teacher intervention provides crucial information for teachers to identify the language demands of peer interaction in their own classrooms and to subsequently design language objectives related to navigating the interactional and social demands of learning science.

6.4.2 Collaborative Classroom Discourse Analysis

Cazden (2001) and Rymes (2009) advocate for teachers to engage in collaborative classroom discourse analysis with their students. Martin and Siry (2012) and Siry and Martin (2014) advocate for preservice and in-service science teachers' use of cogenerative dialogues and video analysis to reflect on their practice and garner student feedback on classroom activities. By entering into collaborative analysis of instruction and discourse with their students, teachers provide themselves and their students with critical insights into the mechanics of learning science in their classrooms. Both students and teachers can use this information to change their practices to better facilitate student learning. I advocate for the inclusion of classroom discourse analysis coursework in both science and language teaching methods courses. In-service teachers should be invited to participate in collaborative research with researchers and preservice teachers in order to be apprenticed into discourse analytic practices.

6.4.3 Train Students in How to Use Lab Equipment

In addition to the broader teacher education approaches described in sections 6.4.1 and 6.4.2, there are a number of explicit teaching practices that teachers might employ to help students overcome barriers to equitable participation and to develop science expertise in science labs. For example, all three focal participants in this study were denied opportunities to develop expertise because they did not know how to use the portable lab computer. As a result, the student who already knew how to use this equipment became the authoritative science expert in the group. Teachers can work against this positioning by providing explicit and individualized instruction on how to use lab computers and other technology. From personal experience as a science teacher, I can attest to the allure of thinking that the one student in the group who “knows” will be able to fill in the other students on how to do something. However, the cases presented in this dissertation demonstrate that without intervention, the student who knows more than the other students will likely (purposefully or inadvertently) deny this knowledge to other students. Thus, teachers can avoid this problem by providing explicit instruction and holding all students accountable for demonstrating knowledge of how to use lab equipment.

6.4.4 Create Rotating Leadership Positions for Science Labs

In addition to teaching all students how to use lab equipment, teachers might also consider shifting peer social dynamics to support learning by creating rotating leadership positions for lab-work. Heath and Street (2008) advocate for language socialization researchers to explore nonclassroom based places (e.g., community theater) that allow students to take up leadership roles that are often denied to them in classroom environments. While I agree that such research is valuable, I also advocate for classroom-based instructional strategies that attempt to place students in leadership roles in the classroom. For example, the teacher in the classroom that served as the site for this study could have created lab groups that students remained in for three to four labs, and required students to rotate through a science expert or lab leader position. To prepare students who may not generally occupy the position of science expert, the teacher could meet with all “experts” the week before the lab for which they would serve as the expert to go over key information, concepts, and procedures. During this time, the teacher could also talk with students about their leadership style and how they might approach interacting with their groups. This strategy would be made even more effective if the teacher also engaged in classroom discourse analysis with students. Students could view video of their own groups interacting and discuss how various leadership strategies are either effective or ineffective at engaging all participants in meaningful ways. This approach does not remove the science expert role from peer interaction, but rather, it attempts to provide all students with the opportunity to occupy the role at multiple points throughout the year and to support them in this process.

Teachers might also consider including a graded component of lab work related to collaboration. A teacher might have rubrics to demonstrate how students should participate in the labs as different roles, i.e., an assistant, the expert/leader. Creating structures that enable all students to occupy the expert position will ensure that all students have access to the content and language learning opportunities that this position affords. Once teachers consider the behaviors that they want students to practice during labs and create rubrics for participation, these practices should modeled, and the teacher should provide students with direct instruction on how to achieve the practices, and feedback on students' lab performance. In order to address equity in science education, teacher educators must prepare teachers with the tools to influence the dynamics of peer-lead disciplinary socialization.

6.4.5 Multilingual Science Fair

My final suggestion for how to provide equitable learning opportunities for diverse learners goes beyond the scope of what one teacher or teacher educator might accomplish alone in her classes. Based on the experiences of the Latino/a students in this study, I believe that schools and districts should provide bilingual students with opportunities to develop academic (in this case, scientific) expertise in their first languages and to share that expertise with the non-native speakers of their home languages in schools. For example, in SFAA almost all of the language learners spoke Spanish as their first language. At the same time, all students were required by the district to complete 2 years of foreign language instruction in order to graduate from high school. Spanish was the only world language offered at SFAA. As a result, L1 Spanish speakers were often placed in Spanish classes with L1 English speakers. Students from a range of backgrounds commented that this practice lead to unresolved tension in the Spanish classroom. Although I was unable to visit the Spanish classrooms (exploring Spanish classroom discourse was not part of my research questions for this study) it was clear to me that the lack of suitable Spanish language classes for L1 Spanish speakers served to delegitimize the language skills and identities of this group of students. Because language ideologies do not begin or end with classroom walls, I believe that the practices of the Spanish language class likely have bearing on how Spanish-speaking students are positioned in their science classes.

Because SFAA has a stated commitment to creating an environment in which diverse students can be successful in attaining a high quality science-focused college preparatory education, it is likely that administrators at the school are unaware of how Spanish-speaking students become disenfranchised in individual classrooms. The school already has an internal science fair annually and all students must design and conduct their own experiments. As a way to validate the language backgrounds of the Spanish-speaking students, I advocate for allowing and encouraging students to conduct and submit their projects in Spanish. Creating this opportunity would require both internal and external support for the students as they create and conduct their independent research but would also require having judges with the adequate linguistic and scientific knowledge to evaluate students' projects. The school's Spanish teachers could be involved in supporting and evaluating these projects, and perhaps Spanish-speaking students could earn foreign language credit towards graduation by completing these academic projects in Spanish. In addition perhaps even advanced L1 English speakers could participate in projects in order to gain immersion-style language learning opportunities.

While creating these multilingual opportunities would be difficult and would require the collaboration of researchers, teachers, and community members, I believe that innovative approaches such as the creation of a multilingual science fair would provide traditionally minoritized students, such as the Latinas in this study, with opportunities to articulate science expert positions and to serve as experts on multiple levels to their non-native Spanish-speaking peers. Providing Latino/a students with opportunities to serve in expert roles in Spanish could carry over to the English-speaking environment of the science classroom. At the very least, the validation of Spanish in an academic context such as a science fair would send a message to all students about the legitimacy of this language and its speakers.

6.5 Final Thoughts and Future Directions

The local classroom identities described in Chapter 4 and the socialization pathways described in Chapter 5 demonstrate the importance of peer interaction in shaping students' development of disciplinary identities in science. In addition to incorporating the suggested teacher education practices listed above into my instruction for preservice teachers, there are five lines of inquiry I intend to pursue as a result of conducting this dissertation research.

First, I plan to integrate my analysis of peer socialization in this ninth-grade physics class with an analysis of teacher-led classroom discourse in whole class interactions. Though the analyses presented in this dissertation demonstrate that students' science learning occurs embedded in the complex social negotiations of peer interaction, it can sometimes be difficult to locate the science in peer-led science classroom discourse when viewing language in isolation. As I move forward in integrating my analyses of whole-class and peer group discourse, I hope to also provide more explicit descriptions of the science knowledge contained in the discourse. In addition, though I did not centralize the role of gender in this dissertation, male and female students appeared to participate in the classroom community in different ways both in whole class settings and small group settings. For example, in whole class settings, female students participated voluntarily much less frequently than male students. As I expand the research to include whole class settings, I will also explore how gender relates to articulations of expertise in this classroom community.

Second, I plan to create a new corpus from the classroom recordings I collected that will allow me to analyze the role of Mock Spanish as a socializing tool in this classroom community. Third, I plan to follow up with participating students who are currently enrolled in their 11th-grade year of high school to collect data for a longitudinal study. By continuing to follow the pathways of socialization of the focal participants into the future, I will be able to see how students' year-to-year experiences in science classes accumulate and influence their long-term engagement with science.

Fourth, I plan to conduct research on the effectiveness of the strategies I recommend in Section 6.4 for shifting peer group dynamics. Fifth, I plan to explore the feasibility of creating opportunities for Spanish-speaking students at SFAA to conduct their end of the year science fair projects in Spanish. Pursuing these lines of research will continue the work that I have started with this dissertation and will hopefully lead to more equitable educational opportunities for language minority youth in science classroom communities.

‘

APPENDIX A

RECORDING LOG FOR CORPUS DATA

Relevant Recordings for Lab 1: Gravity

	P	*Group Members & Recorder*	*Group Members & Recorder*
12/02	1	Manuel & Rico R1	Satan, OneDirectioner, Potato, Rose R2
	2	Manuel & Rico R1	Satan, OneDirectioner, Potato, Rose R2
12/03	1	Manuel & Rico R1, R5	Satan, OneDirectioner, Potato, Rose R2
	2	Manuel & Rico R1, R5	Satan, OneDirectioner, Potato, Rose R2
12/09	1	Manuel & Rico R1	Satan, OneDirectioner, Potato, Rose R2
	2	Manuel, Rico, Alexander R1, R3	Satan, OneDirectioner, Potato, Rose R2
12/10	1	Gu Jun Pyo, Alexander, Manuel R1	Satan, OneDirectioner, Potato, Rose R2
	2	Gu Jun Pyo, Alexander, Manuel R1, R5	Satan, OneDirectioner, Potato, Rose R2
12/11	1	Gu Jun Pyo, Alexander, Manuel R5	Satan, OneDirectioner, Potato, Rose R2, R6
	2	Gu Jun Pyo, Alexander, Manuel R5	Satan, OneDirectioner, Potato, Rose R2
12/15	1	P1: Presentation 3 – Gu Jun Pyo, Rico, Manuel, Alexander	
	2	P2: Presentation 6 – Satan, OneDirectioner, Potato, Rose	

Relevant Recordings for Lab 2: Electrostatic Force

	P	*Group Members & Recorder*	*Group Members & Recorder*
01/15	1	Manuel, Gu Jun Pyo, Rico R1	Satan, OneDirectioner, Potato, Rose R2
01/20	1	Rico, Manuel, Gu Jun Pyo R1	OneDirectioner, Potato, Rose, R2
	2	Rico, Manuel, Gu Jun Pyo R1	OneDirectioner, Potato, Rose, R2

Relevant Recordings for Lab 3: Measuring the speed of a wave

	P	*Group Members & Recorder*
03/09	1	Rose, OneDirectioner, Gu Jun Pyo R1
	2	Rose, OneDirectioner, Gu Jun Pyo, Captain America R1, R4
03/10	1	Rose, OneDirectioner, Gu Jun Pyo, Captain America R1, R2
	2	Rose, OneDirectioner, Gu Jun Pyo, Captain America R1, R2

APPENDIX B

ROUND 1 STUDENT INTERVIEW PROTOCOL

Student Interview Questions – Round 1

General Questions

1. How old are you?
2. How long have you been a student at SFAA?
3. Where were you born?/Were you born here in [state name]?
    a. How long have you been in [state name]?
    b. How long have you been in the United States?
4. Do you like SFAA? Why or why not?
    a. What do you like/dislike about it?
5. What is your favorite class in school and why?
6. What is your least favorite class in school and why?
7. General Questions About You
    a. What do you usually do after school?
    b. What is a typical Saturday like for you? What do you do, who do you hang out with?
    c. If you had a new Pen Pal (or Facebook friend) in another country, how would you describe yourself to that person?
    d. Are most of your friends who you hang out with outside of school also students at SFAA or are most of your close friends from other areas of your life?

Science Related Questions

8. Do you consider yourself a science person? Why or why not?
    a. Who in your class is a science person? Why do you think so?
    b. What does it mean to be a science person? – what does this look like outside of school? Inside of school? Behaviors? Mentality?
9. How is physics class this year different from science class last year?
    a. Did you like science better last year? Why or why not?
10. What is the best part of physics class?
11. What do you like or dislike about the labs in physics class?
12. If you could pick 2-3 lab partners for a physics lab, who would you pick and why?
13. Can you tell me about a time in any science class where you felt successful?
14. Are there any times in science classes when you do/did not feel successful?
    a. Has this happened so far this year?

APPENDIX C

NORMS AND VALUES CARD SORT ITEMS

Statements
USE SCIENTIFIC VOCABULARY WHEN SPEAKING
USE SCIENTIFIC VOCABULARY WHEN WRITING
TALK LIKE A SCIENTIST
WRITE LIKE A SCIENTIST
THINK LIKE A SCIENTIST
VOLUNTEER ANSWERS IN CLASS
PARTICIPATE IN CLASS DISCUSSIONS
ASK GOOD QUESTIONS
COLLECT GOOD DATA
WRITE WELL
EXPLAIN YOUR THINKING
SOLVE PROBLEMS
ANALYZE DATA
WORK WELL WITH OTHERS/HELP OTHERS

APPENDIX D

TRANSCRIPTION CONVENTIONS FOR CLASSROOM DISCOURSE

Symbol	Meaning
.	end of intonation unit; falling intonation
,	end of intonation unit; fall-rise intonation
?	end of intonation unit; rising intonation
!	raised pitch and volume throughout the intonation unit
°°	lower volume
:	length
=	latching; no pause between intonation units
-	self-interruption; break in the word, sound abruptly cut off
(p.p)	measured pause of greater than 0.5 seconds
@	laughter; each token marks one pulse
h	outbreath (e.g., sigh); each token marks one pulse
.h	inbreath
[]	overlapping speech
()	uncertain transcription
/	alternate hearings of uncertain transcription
#	unintelligible; each token marks one syllable
< >	transcriber comment, nonvocal noise, gesture, or gaze

REFERENCES

Abedi, J. (2006). Psychometric issues in the ELL assessment and special education eligibility. *The Teachers College Record, 108*(11), 2282-2303.

Agha, A. (2007). *Language and social relations*. Cambridge, UK: Cambridge University Press.

Alemán, E. (2006). Is Robinhood "the prince of thieves" or the pathway to equity? *Educational Policy, 20*(1), 113-142.

Alemán, E. (2009). Leveraging conflict for social justice: How "leadable" moments can transform school culture. *Journal of Cases in Educational Leadership, 12*(4), 1-16.

Atkinson, J.M., & Heritage, J. (Eds.). (1984). *Structures of social action: Studies in conversation analysis*. Cambridge, UK: Cambridge University Press.

Atkinson, D. (2011). Introduction: Cognitivism and second language acquisition. In D. Atkinson (Ed.), *Alternative approaches to second language acquisition* (pp. 1-23). New York, NY: Routledge.

Bailey, B. (2001). Dominican ‐ American ethnic/racial identities and United States social categories. *International Migration Review, 35*(3), 677-708.

Baquedano-López, P. (2000). Narrating community in Doctrina classes. *Narrative Inquiry, 10*(2), 1-24.

Barrett, R. (1999). Indexing polyphonous identity in the speech of African American drag queens. In M. Bucholtz, A. C. Liang, & L. A. Sutton (Eds.), *Reinventing identities: The gendered self in discourse* (pp. 313-331). New York, NY: Oxford University Press.

Basu, S. J., & Calabrese Barton, A. (2007). Developing a sustained interest in science among urban minority youth. *Journal of Research in Science Teaching, 44*(3), 466-489.

Beckett, G. H. (2005). Academic language and literacy socialization through project-based instruction: ESL student perspectives and issues. *Journal of Asian Pacific*

Communication, 15(1), 191-206.

Bernard, H.R. (2006). *Research methods in anthropology: Qualitative and quantitative approaches* (4th ed.). Lanham, MD: Altamira Press.

Bloome, D., Carter, S., Christian, B., Otto, S., & Shuart-Faris, N. (2005). *Discourse analysis and the study of classroom language and literacy events: A microethnographic perspective*. Mahwah, NJ: Lawrence Erlbaum Associates.

Bourdieu, P. (1999). Excerpt from: Language and symbolic power, 1991. In A. Jaworski & N. Coupland (Eds.), *The discourse reader* (pp. 480-490). New York: Routledge.

Brayboy, B., & Dehyle, D. (2000). Insider-outsider: Researchers in American Indian communities. *Theory Into Practice, 39*(3), 163-169.

Brown, B. A. (2004). Discursive identity: Assimilation into the culture of science and its implications for minority students. *Journal of Research in Science Teaching, 41*(8), 810-834.

Brown, B. A. (2006). "It isn't no slang that can be said about this stuff": Language, identity, and appropriating science discourse. *Journal of Research in Science Teaching, 43*(1), 96-126.

Brown, B. A., Reveles, J. M., & Kelly, G. J. (2005). Scientific literacy and discursive identity: A theoretical framework for understanding science learning. *Science Education, 89*(5), 779-802.

Bucholtz, M. (2011). *White kids: Language, race, and styles of youth identity*. New York, NY: Cambridge University Press.

Bucholtz, M., Barnwell, B., Skapoulli, E., & Lee, J.-E. J. (2012). Itineraries of identity in undergraduate science. *Anthropology & Education Quarterly, 43*(2), 157-172.

Bucholtz, M., & Hall, K. (2008). Finding identity: Theory and data. *Multilingua, 27*(1-2), 151-163.

Bucholtz, M., Skapoulli, E., Barnwell, B., & Lee, J.-E. J. (2011). Entextualized humor in the formation of scientist identities among U.S. undergraduates. *Anthropology & Education Quarterly, 42*(3), 177-192.

Bucholtz, M., & Hall, K. (2004). Language and identity. In A. Duranti (Ed.), *A companion to linguistic anthropology* (pp. 369-394). Oxford, UK: Blackwell.

Calabrese Barton, A. (2001). Science education in urban settings: Seeking new ways of praxis through critical ethnography. *Journal of Research in Science Teaching,* *38*(8), 899-917.

Calabrese Barton, A., & Tan, E. (2009). Funds of knowledge and discourses and hybrid space. *Journal of Research in Science Teaching, 46*(1), 50-73.

Carlone, H. B. (2012). Methodological considerations for studying identities in school science: An anthropological approach. In M. Varelas (Ed.), *Identity construction and science education research: Learning, teaching, and being in multiple contexts.* (pp. 9-26). Rotterdam, NE: Sense Publishers.

Carlone, H. B., Haun-Frank, J., & Webb, A. (2011). Assessing equity beyond knowledge- and skills-based outcomes: A comparative ethnography of two fourth-grade reform-based science classrooms. *Journal of Research in Science Teaching, 48*(5), 459-485.

Carr, E.S. (2010). Enactments of expertise. *Annual Review of Anthropology, 39*, 17-32.

Cazden, C. B. (1988). *Classroom discourse: The languaguage of teaching and learning*. Portsmouth, NH: Heinemann Educational Books, Inc.

Cazden, C. B. (2001). *Classroom discourse: The language of teaching and learning*. Portsmouth, NH: Heinemann.

Chavez, C. (2008). Conceptualizing from the inside: Advantages, complications, and demands on insider positionality. *The Qualitative Report, 13*(3), 474-494.

Cho, J., & Trent, A. (2006). Validity in qualitative research revisited. *Qualitative Research 6*(3), 319-340.

Chun, E. (2007). *The meaning of mocking: Stylizations of Asians and preps at a U.S. high school.* Unpublished dissertation. University of Texas at Austin.

Chun, E. W. (2001). The construction of white, black, and Korean American identities through African American Vernacular English. *Journal of Linguistic Anthropology, 11*(1), 52-64.

Cole, K. (2002). *Negotiating the 'daily calendar': A language socialization perspective of diverse learners in a mainstream science class.* Unpublished dissertation. University of Wisconsin, Madison.

Cole, K., & Zuengler, J. (2003). Engaging in an authentic sciecne project: Appropriating, resisting, and denying "scientific" identities. In R. Bayley & S. Schecter (Eds.), *Language socialization in bilingual and multilingual societies* (pp. 98-113). Clevedon, UK: Multilingual Matters.

Doughty, C., & Williams, J. (Eds.). (1998). *Focus on form in classroom second language* *acquisition*. Cambridge, UK: Cambridge University Press.

DuBois, J., Cumming, S., S., S.-C., & Paolino, D. (1992). Discourse transcription. *Santa Barbara papers in linguistics: Volume 4*. University of California, Santa Barbara, Department of Linguistics.

Duff, P. A. (1995). An ethnography of communication in immersion classrooms in Hungary. *TESOL Quarterly, 29*(3), 505-537.

Duff, P. A. (2002). The discursive co-construction of knowledge, identity, and difference: An ethnography of communication in the high school mainstream. *Applied Linguistics, 23*(3), 289-322.

Duff, P. A. (2004). Intertextuality and hybrid discourses: The infusion of pop culture in educational discourse. *Linguistics and Education, 14*(3), 231-276.

Duff, P. A. (2008). *Case study research in applied linguistics*. New York, NY: Taylor & Francis Group.

Duff, P. A. (2010). Language socialization into academic discourse communities. *Annual Review of Applied Linguistics, 30*, 169-192.

Duff, P. A., & Talmy, S. (2011). Language socialization approaches to second language acquisition: Social, cultural, and linguistic development in additional languages. In D. Atkinson (Ed.), *Alternative approaches to second language acquisition* (pp. 95-116). New York, NY: Routledge.

Echevarria, J. (2005). Using SIOP in science: Response to Settlage, Madsen, and Rustad. *Issues in Teacher Education, 14*(1), 59-62.

Echevarria, J., Vogt, M. E. J., & Short, D. (2013). *Making content comprehensible for English learners: The SIOP model* (4th ed.). Upper Saddle River, NJ: Pearson.

Eckert, P. (2000). *Linguistic variation as social practice: The linguistic construction of identity in Belton high*. Malden, MA: Blackwell.

Eckert, P. (2008). Variation and the indexical field. *Journal of Sociolinguistics, 12*(4), 453-476.

Eckert, P. (2012). Three waves of variation study: The emergence of meaning in the study of sociolinguistic variation. *Annual Review of Anthropology, 41*(1), 87-100.

Edwards, A., & Westgate, D. P. (1994). *Investigating classroom talk*. London, UK: The Falmer Press.

Edwards, A. D., & Westgate, D. P. G. (1994). *Investigating classroom talk* (2nd ed.).

London, UK: The Falmer Press.

Egbert, J. (2013). *Toward a linguistic taxonomy of English academic writing*. Paper presented at the University of Utah Student Conference in Linguistics, Salt Lake City, Utah.

Egbert, J. (2014). *Reader perceptions of linguistic variation in published academic writing*. Unpublished dissertation. University of Arizona, Tuscon.

Evans-Pritchard, E. E. (1937). *Witchcraft, oracles and magic among the Azande*. Oxford, UK: Clarendon Press.

Fishman, J. A. (1972). The relationship between micro- and macro-sociolinguistics in the study of who speaks what language to whom and when. In J. B. Pride & J. Holmes (Eds.), *Sociolinguistics: Selected readings* (pp. 15-32). Middlesex, UK: Penguin.

Foley, D. E. (2000). The politics of studying Raza Unida politics: Reflections of a white anthropologist. In R. R. Flores (Ed.), *Reflexiones 1999: New directions in Mexican American Studies* (pp. 51-80). Austin, TX: Center for Mexican American Studies.

Foucault, M. (1980). *Power/Knowledge: Selected interviews and other writings 1972-1977*. New York, NY: Pantheon Books.

Gallas, K. (1995). *Talking their way into science: Hearing children's questions and theories, responding with curricula*. New York, NY: Teachers College Press.

Garrett, P. B. (1999). *Language socialization, convergence, and shift in St. Lucia, West Indies*. Unpublished dissertation. New York University.

Garrett, P. B., & Baquedano-López, P. (2002). Language socialization: Reproduction and continuity, transformation and change. *Annual Review of Anthropology*, 339-361.

Gee, J. (2005). Language in the science classroom: Academic social languages as the heart of school-based literacy. In R. Yerrick & W. M. Roth (Eds.), *Establishing scientific classroom discourse communities* (pp. 19-37). Mahwah, NJ: Lawrence Erlbaum.

Gee, J. (2011). *An introduction to discourse analysis: Theory and method*. New York, NY: Routledge.

Gee, J. P. (1996). *Social linguistics and literacies: Ideology in discourses*. London, UK: Taylor & Francis.

Geertz, C. (1973). *The interpretation of cultures: Selected essays*. New York, NY: Basic

Books.

Gibbons, P. (2003). Mediating language learning: Teacher interactions with ESL students in a content-based classroom. *TESOL Quarterly, 37*(2), 247-273.

Ginsberg, D. (2015). Multimodal semiotics of mathmatics teaching and learing (Doctoral dissertation). Retrieved from ProQuest. (ISBN: 9781339311517)

Glesne, C. (2011). *Becoming qualitative researchers* (4th ed.). Boston, MA: Pearson.

Gumperz, J. J., & Cook-Gumperz, J. (2008). Studying language, culture, and society: Sociolinguistics or linguistic anthropology? *Journal of Sociolinguistics, 12*(4), 532-545.

Halliday, M. A. (1994). *An introduction to functional grammar* (2nd ed.). London, UK: Edward Arnold.

Halliday, M. A. K. (1975). *Learning how to mean: Explorations in the development of language*. London, UK: Edward Arnold.

Hanrahan, M. U. (2006). Highlighting hybridity: A critical discourse analysis of teacher talk in science classrooms. *Science Education, 90*(1), 8-43.

Harklau, L. (2003). Representational practices and multi-modal communication in US high schools: Implications for adolescent immigrants. In R. Bayley & S. Schecter (Eds.), *Language socialization in bilingual and multilingual societies* (pp. 83-97). Clevedon, UK: Multilingual Matters.

Hatch, J. A. (2002). *Doing qualitative research in education settings*. Albany, NY: SUNY Press.

Hayes-Harb, R., Nicol, J., & Barker, J. (2010). Learning the phonological forms of new words: Effects of orthographic and auditory input. *Language and Speech, 53*(3), 367-381.

Heath, S. B. (1983). *Ways with words: Language, life and work in communities and classrooms*. Cambridge, UK: Cambridge University Press.

Heath, S. B., & Street, B. V. (2008). *On ethnography: Approaches to language and literacy research*. New York, NY: Teachers College Press.

Heller, M. (2001). Legitimate language in a multilingual school. In M. Heller & M. Martin-Jones (Eds.), *Voices of authority: Education and linguistic difference* (pp. 381-402). Westport, CT: Ablex.

Hill, J. (1999). Language, race, and white public space. *American Anthropologist, 100*(3), 680-689.

Hill, J. (2008). *The everyday language of white racism*. Chichester, U.K.: Wiley-Blackwell.

Hornstein, N., Nunes, J., & Grohmann, K. (2005). *Understanding minimalism*. Cambridge, UK: Cambridge University Press.

Hymes, D. (1972). On communicative competence. In J. B. Pride & J. Holmes (Eds.), *Sociolinguistics: Selected readings* (pp. 269-293). Middlesex, UK: Penguin.

Jacoby, S. (1998). *Science as performance: Socializing scientific discourse through the conference talk rehearsal.* Unpublished dissertation. University of California, Los Angeles.

Kamberelis, G., & Wehunt, M. D. (2012). Hybrid discourse practice and science learning. *Cultural Studies of Science Education*, *7*(3), 505-534.

Kärkkäinen, E. (2003). *Epistemic stance in English conversation: A description of its interactional functions, with a focus on I think*. Amsterdam: John Benjamins.

Kelly, G. J. (2012). Expanding discourse repertoires with hybridity. *Cultural Studies of Science Education*, *7*(3), 535-539.

Kermes, H., & Teich, E. (2012). Formulaic expressions in scientific texts: Corpus design, extraction and exploration. *Lexicographica, 28*(1), 99-119.

Labov, W. (2002). Book review: Linguistic variation as social practice by Penelope Eckert. *Language in Society, 31*(2), 277-284.

Latour, B. (1999). *Pandora's hope: Essays on the reality of science studies*. Cambridge, MA: Harvard University Press.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Lee, O. (2003). Equity for linguistically and culturally diverse students in science education: A research agenda. *Teachers College Record, 105*(3), 465-489.

Lee, O., Buxton, C., Lewis, S., & LeRoy, K. (2006). Science inquiry and student diversity: Enhanced abilities and continuing difficulties after an instructional intervention. *Journal of Research in Science Teaching, 43*(7), 607-636.

Lee, O., & Fradd, S. H. (1998). Science for all, including students from non-English-language backgrounds. *Educational Researcher, 27*(4), 12-21.

Lemke, J. (2000). Across the scales of time. *Mind, Culture and Activity, 7*, 273-290.

Lemke, J. (1990). *Talking science: Language, learning, and values*. Norwood, NJ: Ablex Publishing Corporation.

Lewis, J., Menzies, H., Nájera, E., & Page, R. (2009). Rethinking trends in minority participation in the sciences. *Science Education, 93*(6), 961-977.

MacSwan, J., & Rolstad, K. (2006). How language proficiency tests mislead us about ability: Implications for English language learner placement in special education. *The Teachers College Record, 108*(11), 2304-2328.

Marshall, C., & Rossman, G. (2011). *Designing qualitative research* (5th ed.). Thousand Oaks, CA: Sage.

Martin, S., & Siry, C. (2012). Using video in science teacher education: An analysis of the utilization of video-based media by teacher educators and researchers. In B.J. Fraser, K.G. Tobin, & C.J. McRobbie (Eds.). *Second international handbook of science education* (pp. 417-433). Dordrecht, NL: Springer.

Massoud, L. A., & Kuipers, J. C. (2008). Objectification and the inscription of knowledge in science classrooms. *Linguistics and Education, 19*(3), 211-224.

Maybin, J. (2003). Voices, intertextuality and induction into schooling. In S. Goodman, T. Lillis, J. Maybin, & N. Mercer (Eds.), *Language, literacy, and education: A reader* (pp. 159-170). Staffordshire, UK: Trentham Books.

Meek, B. (2001). *Kaska language socialization, acquisition, and shift*. Unpublished dissertation. University of Arizona, Tuscon.

Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Cambridge, MA: Harvard University Press.

Mehan, H. (1998). The study of social interaction in educational settings: Accomplishments and unresolved Issues. *Human Development, 41*(4), 245-269.

Mendoza-Denton, N. (2008). *Homegirls: Language and cultural practice among Latina youth gangs*. New York, NY: John Wiley & Sons.

Miller, E. R., & Zuengler, J. (2011). Negotiating access to learning through resistance to classroom practice. *The Modern Language Journal, 95*, 130-147.

Moje, E. B., Collazo, T., Carrillo, R., & Marx, R. W. (2001). "Maestro, what is 'quality'?": Language, literacy, and discourse in project-based science. *Journal of Research in Science Teaching, 38*(4), 469-498.

National Academy of Sciences. (1996). *National science education standards*. Washington, DC: National Academy Press.

National Academy of Sciences. (1997). *Science for all children: A guide to improving elementary science education in your school district*. Washington, DC: National Academy Press.

Norris, J. M., & Ortega, L. (2000). Effectiveness of L2 instruction: A research synthesis and quantitative meta-analysis. *Language Learning, 50*(3), 417-528.

Norton Peirce, B. (1995). Social identity, investment, and language learning. *TESOL Quarterly, 29*(1), 9-31.

Norton, B., & McKinney, C. (2011). An identity approach to second language acquisition. In D. Atkinson (Ed.), *Alternative approaches to second language acquisition* (pp. 73-94). New York, NY: Routledge.

O'Barr, W., & Atkins, B. (1980). "Women's language" or "powerless language". In S. McConnell-Ginet, R. Borker, & N. Furman (Eds.), *Women and language in literature and society* (pp. 93-110). New York, NY: Praeger Publishers.

Ochs, E. (1979). Transcription as theory. *Developmental Pragmatics*, 43-72.

Ochs, E., & Schieffelin, B. (1984). Language acquisition and socialization: Three developmental stories and their implications. In R. Shweder & R. LeVine (Eds.), *Culture theory* (pp. 276-320). Cambridge, UK: Cambridge University Press.

Ochs, E., & Schieffelin, B. (2008). Language socialization: An historical overview. In N. H. Hornberger & P. A. Duff (Eds.), *Encyclopedia of language and education, volume 8: Language Socialization* (pp. 3-16). New York, NY: Springer.

O'Connor, K. (2003). Communicative practice, cultural production, and situated learning: Constructing and contesting identities of expertise in a hetereogeneous learning context. In S. Wortham & B. Rymes (Eds.), *Linguistic anthropology of education* (pp. 61-91). Westport, CT: Praeger.

Philips, S.U. (1993). Introduction, *The invisible culture*. Long Grove, IL: Waveland Press.

Philips, S. U. (1983). *The invisible culture: Communication in classroom and community on the Warm Springs reservation*. Long Grove, IL: Waveland Press, Inc.

Ready, D. (2010). Socioeconomic disadvantage, school attendance, and early cognitive development: The differential effects of school exposure. *Sociology of Education, 83*(4), 271-286.

Richards, J. C. (1987). The dilemma of teacher education in TESOL. *TESOL Quarterly, 21*(2), 209-226.

Rifkin, W.D., & Martin, B. (1997). Negotiating expert status: Who gets taken seriously. *IEEE Technology and Society Magazine*, Spring.

Rochin, R., & Mello, S. (2007). Latinos in science. *Journal of Hispanic Higher Education, 6*(4), 305-355.

Rosebery, A. S., Warren, B., & Conant, F. R. (1992). Appropriating scientific discourse: Findings from language minority classrooms. *The Journal of the Learning Sciences, 2*(1), 61-94.

Rymes, B. (2009). *Classroom discourse analysis: A tool for critical reflection*. Cresskill, NJ: Hampton Press, Inc.

Rymes, B., & Anderson, K. (2004). Second language acquisition for all: Understanding the interactional dynamics of classrooms in which Spanish and AAE are spoken. *Research in the Teaching of English*, 107-135.

Rymes, B. R. (2001). *Conversational borderlands: Language and identity in an alternative urban high school*. New York, NY: Teachers College Press.

Rymes, B. R. (2003). Relating word to world: Indexicality during literacy events. In S. Wortham & B. Rymes (Eds.), *Linguistic anthropology of education* (pp. 121-150). Westport, CT: Praeger.

Saville-Troike, M. (1982). *The ethnography of communication: An introduction*. Oxford, UK: Basil Blackwell.

Schleppegrell, M., & Achugar, M. (2003). Learning language and learning history: A functional linguistics approach. *TESOL Journal, 12*(2), 21-27.

Schleppegrell, M. J. (2004). *The language of schooling: A functional linguistics perspective*. Mahwah, NJ: Lawrence Erlbaum Associates.

Schleppegrell, M. J., Achugar, M., & Oteíza, T. (2004). The grammar of history: Enhancing content-based instruction through a functional focus on language. *TESOL Quarterly,, 38*(1), 67-93.

Schleppegrell, M. J., & Colombi, M. C. (2002). *Developing advanced literacy in first and second languages: Meaning with power*. Mahwah, NJ: Lawrence Erlbaum.

Seedhouse, P. (2004). *The interactional architecture of the language classroom: A conversation analysis perspective*. Malden, MA: Blackwell.

Settlage, J., Madsen, A., & Rustad, K. (2005). Inquiry science, sheltered instruction, and English language learners: Conflicting pedagogies in highly diverse classrooms. *Issues in Teacher Education, 14*(1), 39-57.

Sewell, W. (1992). A theory of structure: Duality, agency, and transformation. *American Journal of Sociology, 98*(1), 1-29.

Sherif, B. (2001). The ambiguity of boundaries in the fieldwork experience: Establishing rapport and negotiating insider/outsider status. *Qualitative Inquiry, 7*(4), 436-447.

Shuman, A. (1986). *Storytelling rights: The uses of oral and written texts by urban adolescents*. Cambridge, UK: Cambridge University Press.

Silverstein, M. (1976). Shifters, linguistic categories, and cultural description. *Meaning in Anthropology*, 11-55.

Siry, C., & Martin, S. (2014). Facilitating reflexivity in preservice science teacher education using video analysis and cogenerative dialogue in field-based methods courses. *Eurasia Journal of Mathematics, Science & Technology Education, 10*(5), 481-508.

Sullivan, A. L. (2011). Disproportionality in special education identification and placement of English language learners. *Exceptional Children, 77*(3), 317-334.

Tan, E., & Calabrese Barton, A. (2008a). From peripheral to central, the story of Melanie's metamorphosis in an urban middle school science class. *Science Education, 92*(4), 567-590.

Tan, E., & Calabrese Barton, A. (2008b). Unpacking science for all through the lens of identities-in-practice: The stories of Amelia and Ginny. *Cultural Studies of Science Education, 3*(1), 43-71.

Tan, E., & Calabrese Barton, A. (2010). Transforming science learning and student participation in sixth grade science: A case study of a low-income, urban, racial minority classroom. *Equity & Excellence in Education, 43*(1), 38-55.

U.S. Census Bureau. (2011). American Community Survey. Retrieved May 7, 2012, from http://www.census.gov/acs/www/

U.S. Department of Commerce. (2011a). Education supports racial and ethnic equality in STEM. Retrieved January 14, 2012, from http://www.esa.doc.gov/sites/default/files/reports/documents/educationsupportsracialandethnicequalityinstem_0.pdf

U.S. Department of Commerce. (2011b). STEM: good jobs now and for the future. Retrieved January 15, 2012, from http://www.esa.doc.gov/sites/default/files/reports/documents/stemfinalyjuly14_1.pdf

Vickers, C. H. (2007). Second language socialization through team interaction among electrical and computer engineering students. *The Modern Language Journal, 91*(4), 621-640.

Viechnicki, G. B. (2008). Grammatical processes of objectification in a middle school science classroom. *Linguistics and Education: An International Research Journal, 19*(3), 244-264.

Wortham, S. (1994). *Acting out participant examples in the classroom*. Philadelphia, PA: John Benjamins.

Wortham, S. (2001). *Narratives in action*. New York: Teacher's College Press.

Wortham, S. (2006). *Learning identity: The joint emergence of social identification and academic learning.* New York, NY: Cambridge University Press.

Wortham, S. (2008). The objectification of identity across events. *Linguistics and Education, 19*(3), 294-311.

Wortham, S. (2005). Socialization beyond the speech event. *Journal of Linguistic Anthropology, 15*(1), 95-112.

Wortham, S., & Reyes, A. (2015). *Discourse analysis beyond the speech event*. London: Routledge.

Zappa-Hollman, S. (2007). Academic presentations across post-secondary contexts: The discourse socialization of non-native English speakers. *Canadian Modern Language Review/La Revue canadienne des langues vivantes, 63*(4), 455-485.

Zwiers, J. (2008). *Building academic language: Essential practices for content classrooms, grades 5-12*. San Francisco, CA: John Wiley & Sons.